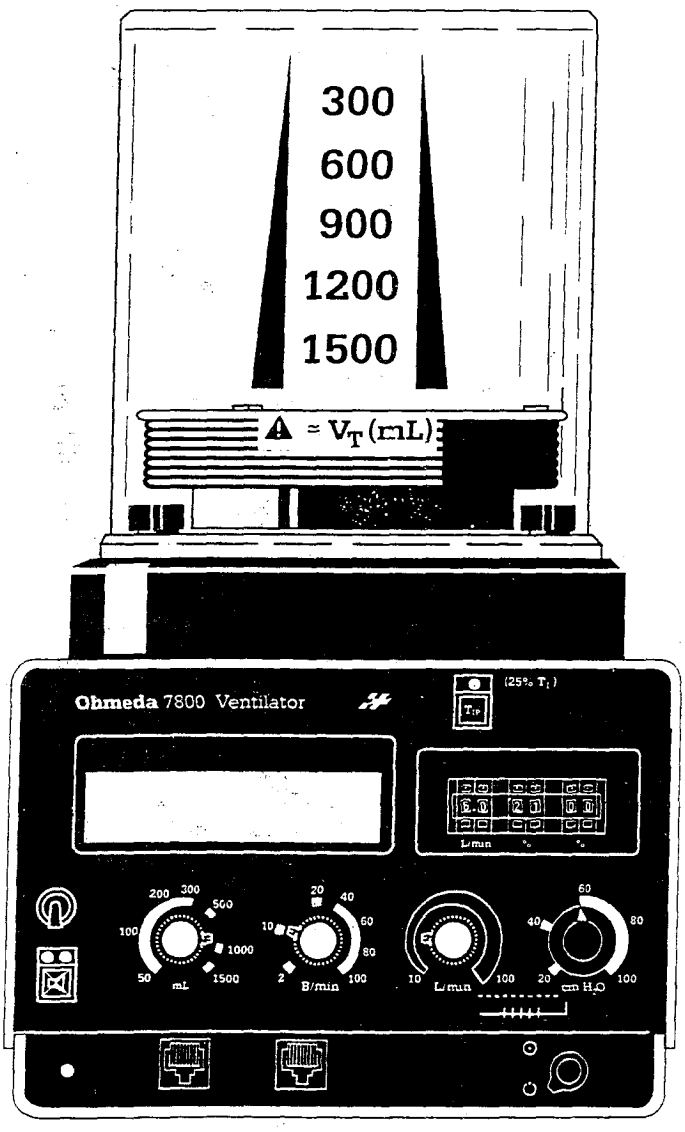
Ohmeda

7800 International Ventilator
Product Group Code CAX
Service Manual



A BOC Health Care Company

Critical Care Worldwide

Ohmeda

Service Manual

7800 International Ventilator
Product Group Code CAX

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Important

The information contained in this service manual pertains only to those models of products which are marketed by Ohmeda as of the effective date of this manual or the latest revision thereof. This service manual was prepared for exclusive use by Ohmeda service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, Ohmeda provides this service manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from Ohmeda does not imply in any way that Ohmeda deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Service Education, Ohmeda, Ohmeda Drive, Madison, Wisconsin 53707.

⚠ **CAUTION: Servicing of this product in accordance with this service manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.**

Technical Competence

The procedures described in this service manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

It is strongly recommended that genuine replacement parts manufactured or sold by Ohmeda be used for all maintenance, service and repair involving this product.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

1/Introduction

1.1 Notes, Cautions and Warnings

Throughout this manual notes, cautions and warnings have special meaning:

Note: Is used to stress a point.

Important: Is similar to a note but used for greater emphasis.

⚠CAUTION: Is for procedures or information that must be closely followed to help prevent possible damage to equipment.

⚠WARNING: Is for procedures or information that must be closely followed to help prevent injury to people.

1.2 Symbols

The following symbols are used on Ohmeda products and technical manuals. No one product or manual has every symbol listed.

On (power)

Off (power)

Standby

Standby or preparatory state for a part of the equipment

"ON" only for part of the equipment

"OFF" only for part of the equipment

Direct Current

Alternating Current

Protective earth ground

Earth Ground

Frame or chassis ground

Alarm silence button

Equipotential

Variability

Variability in steps

Plus, positive polarity

Minus, negative polarity

Lamp, lighting, illumination

Movement in one direction

Movement in both directions

Lock

Unlock

Non-autoclavable

Type B equipment

Type BF equipment

Type CF equipment

Warning ISO 7000-0085

Caution, ISO 7000-0434

Attention, consult accompanying documents, IEC 601-1

This way up

Dangerous Voltage

Input

Output

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1.3 Standard Service Procedures

Operation and Service Manuals
You must have, and be familiar with, the the Operation and Maintenance manuals for this product. Study the Anesthesia System Operation and Maintenance manuals if you need further information about the operation of the system. You must determine where a problem is located before you can determine which service manual to use. Refer to the various service manuals or accessory manuals if you require more information.

Autoclavable Bellows Assembly
The Autoclavable Bellows Assembly is operator maintainable. For more information see the Ventilator Operation and Maintenance manual, or the Autoclavable Bellows Assembly, Operation and Maintenance Supplement.

Stock Numbers for Replacement Parts
Stock Numbers can be identified in the "8/Illustrated Parts List" section of this manual. Parts can be obtained through Ohmeda offices/distributors.

Ventilator tests
Normal operational tests can be performed while the Ventilator is installed in, or attached to, an Anesthesia System. Calibration, troubleshooting or repair may require removing the Ventilator from the Anesthesia System.

⚠WARNING: Section "4/Test and Calibration" must be performed whenever you remove a Ventilator cover, to verify that all critical parts of the Ventilator are still operational and within specification.

⚠WARNING: After the Ventilator has been serviced, you must perform section "3/Post-Service Checkout" to verify the entire Anesthesia System before the system can be returned to clinical use.

⚠WARNING: Do not perform testing or maintenance on this instrument while it is being used to ventilate a patient, possible injury may result.

1.4 7800 Ventilator Configurations

The 7800 Ventilator (hereafter called Ventilator) is available in significantly different product packages. The easiest way to distinguish between the different Ventilators is by the extended pneumatic compartment that sticks out the back. This manual is exclusively for the Ventilator with the extended pneumatic compartment and Product Group Code CAX. Verify the Product Group Code before you proceed.

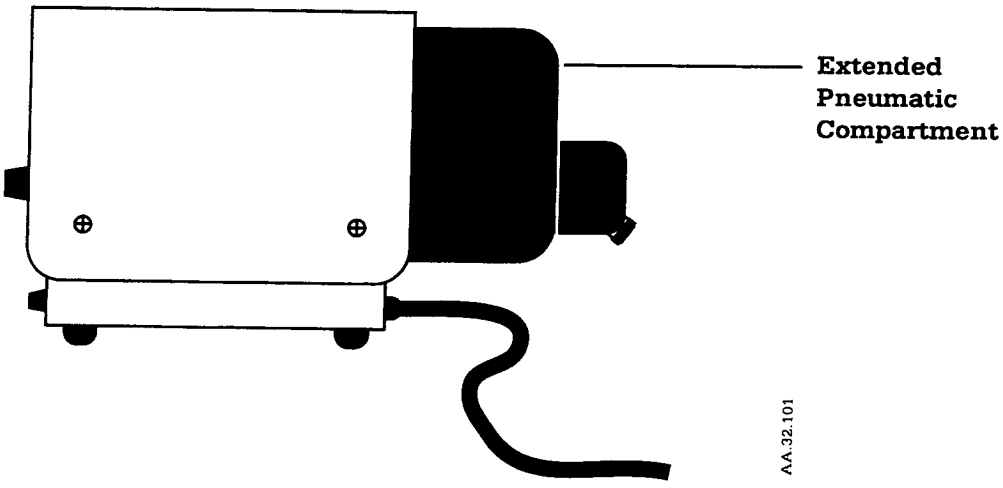


Figure 1-1 7800 Configuration

The Ventilator's two basic units:

- the **Bellows Assembly**; which contains the Bellows and Bellows Housing, and
- the **Control Module**; containing the control valves, processing circuits, controls, monitors and display screen.

The Ventilator is available in two configurations:

- **Excel Mount**; as an integrated Ventilator in an Ohmeda Excel Anesthesia System, or as a
- **Stand-alone**; for use with other Anesthesia Systems.

Differences in these configurations include:

- How the Control Module and Bellows Assembly are mounted.
- Connections between the Control Module, Bellows Assembly and Anesthesia System.
- Connection of the oxygen and volume sensors.

A. Stand-alone

The Control Module can be mounted on an optional arm, or stand.

The Bellows Assembly can be mounted on top of the Control Module, or directly to an Ohmeda GMS absorber (using an interface manifold).

A power switch on the lower front panel, controls Ventilator power up.

Oxygen and volume sensors connect directly to the lower front panel of the Control Module.

Figure 1-2 Stand-alone

B. Excel Mount

The Control Module can be mounted on an optional arm, or from the system shelf.

On systems with flowmeters extending all the way to the top shelf, the Control Module can hang, by a bracket, from the shelf to the right side of the flowmeters.

On systems with the lower shelf extending over the flowmeters, the Control Module can hang, by a bracket, directly from the shelf over the flowmeters.

The Bellows Assembly can be mounted on top of the Control Module, on an optional arm, or directly to an Ohmeda GMS absorber (using an interface manifold).

The Anesthesia System On/Standby switch, controls Ventilator power up.

Oxygen and volume sensor connections are located on the front left or right side of the Excel, below the table top.

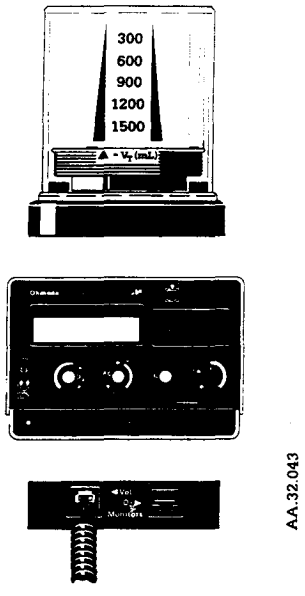
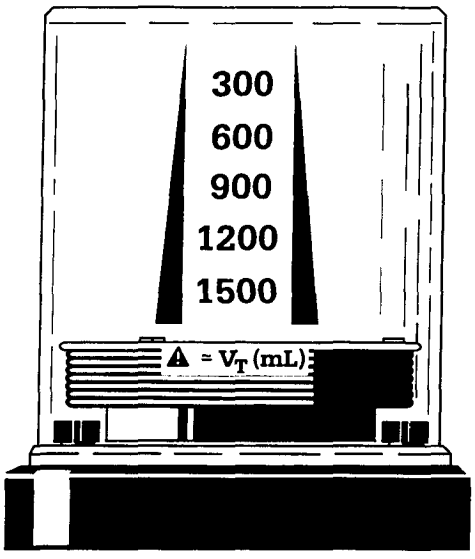


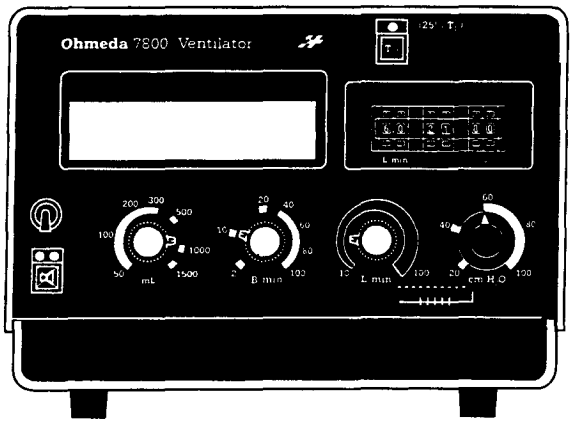
Figure 1-3 Excel Mount

2.0 Ventilator overview

The Ventilator provides mechanical ventilation of patients during surgery. It is a microprocessor controlled pneumatic device. The Ventilator consists of two major parts:

- The Bellows Assembly; which isolates the Driving Gas from the Breathing Gas.
- The Control Module; which contains the electronic and pneumatic components, moves Breathing Gas via the Bellows Assembly, and monitors oxygen, pressures and volumes.





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2/Theory of Operation

The Control Module

The Control Module is usually mounted inside the Anesthesia System, near the flowmeters. Knobs and switches on the front of the Control Module are used to select operational parameters. A Liquid Crystal Display shows current parameter information, alarms and error messages. The Front Panel also has an Alarm Silence Button with a red and a yellow alarm light (Light Emitting Diodes).

The Control Module uses a compressed gas source (typically compressed oxygen) to pneumatically control patient ventilation. The gas is usually supplied by the Anesthesia System from either attached cylinders or a pipeline Gas Supply.

A microprocessor controls the operation of the Control Module. The microprocessor performs all of the timing, monitoring and sequencing involved in applying positive controlled pressure to the Bellows.

The main program memory is an EPROM (Erasable Programmable Read Only Memory). This memory retains its contents when the power is turned OFF. The EPROM holds the permanent preprogrammed application software package. The software revision number can be displayed in a special subroutine called the "Setup Page."

Certain user set parameters are stored in an EEPROM (Electrically Erasable Programmable Read Only Memory) that can be altered under program control. These include operator selected parameters that may vary between sites, such as speaker volume or altitude setting, and are not likely to be changed during a case. The EEPROM also contains the factory set calibration parameters for the Flow Control Valve (part of the Pneumatic Manifold assembly). The calibration parameters can not be programmed in the field.

Ventilator data can be communicated to another device through an RS232 connection.

The Bellows Assembly

The Drive Gas output of the Control Module is used to impress patient gas on the patient through a Bellows. The Drive Gas is on the outside of the Bellows and the patient gas is isolated on the inside. There is no direct connection between the two gas volumes. The Ventilator moves breathing gas to the patient by applying positive pressure on the breathing circuit. Exhalation occurs when the Ventilator releases the positive Drive Gas pressure to atmosphere.

The Ventilator Drive Gas output is connected to the Bellows Assembly by a flexible hose. A small diameter pressure sensing tube connects the patient Breathing Circuit to the Control Module which monitors pressure in the Breathing Circuit. The operator can select an adjustable inspiratory pressure limit which limits the inspiration phase of ventilation when excess pressure is detected.

An independent Pressure Relief Valve is located inside the Bellows. If excess gas accumulates during exhalation, this valve will open and exhaust the excess breathing gas.

2/Theory of Operation

2.1 Pneumatic Description

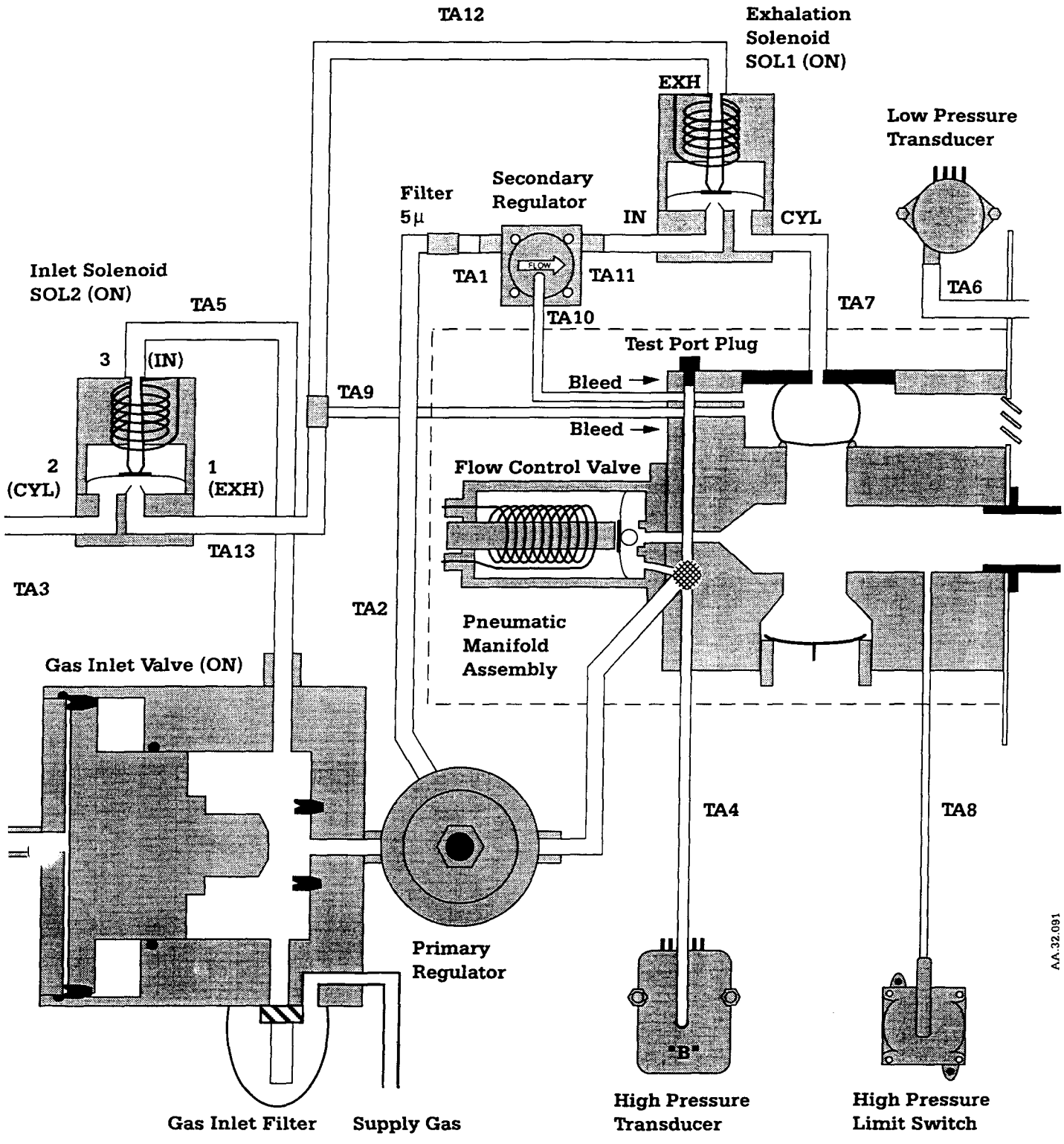


Figure 2-1 Block Diagram Pneumatic Circuit.

A. Gas Inlet Valve

The Gas Inlet Valve switches the Supply Gas entering the Control Module. The Gas Inlet Valve and Inlet Solenoid together form a valve that is normally OFF. The Supply Gas is turned ON by the microprocessor at power up. If the electrical power ever fails, the Gas Inlet Valve shuts OFF.

Inside the Gas Inlet Valve is a Shuttle (Spoppet). The Shuttle has a small control stop on one end which blocks or allows the flow of Supply Gas to the Primary Regulator.

When the Inlet Solenoid is OFF, a pressure differential holds the Shuttle in the closed position.

The Inlet Solenoid must be activated (have current flow) in order for the Gas Inlet Valve to allow Supply Gas into the Control Module.

When the Inlet Solenoid is turned ON, the energized coil attracts a plug that blocks the inlet orifice. At the same time, the exhaust orifice is opened. The compressed gas at the large side of the Shuttle is vented through the Inlet Solenoid. The pressure on the small side of the Shuttle moves it, opening the Gas Inlet Valve.

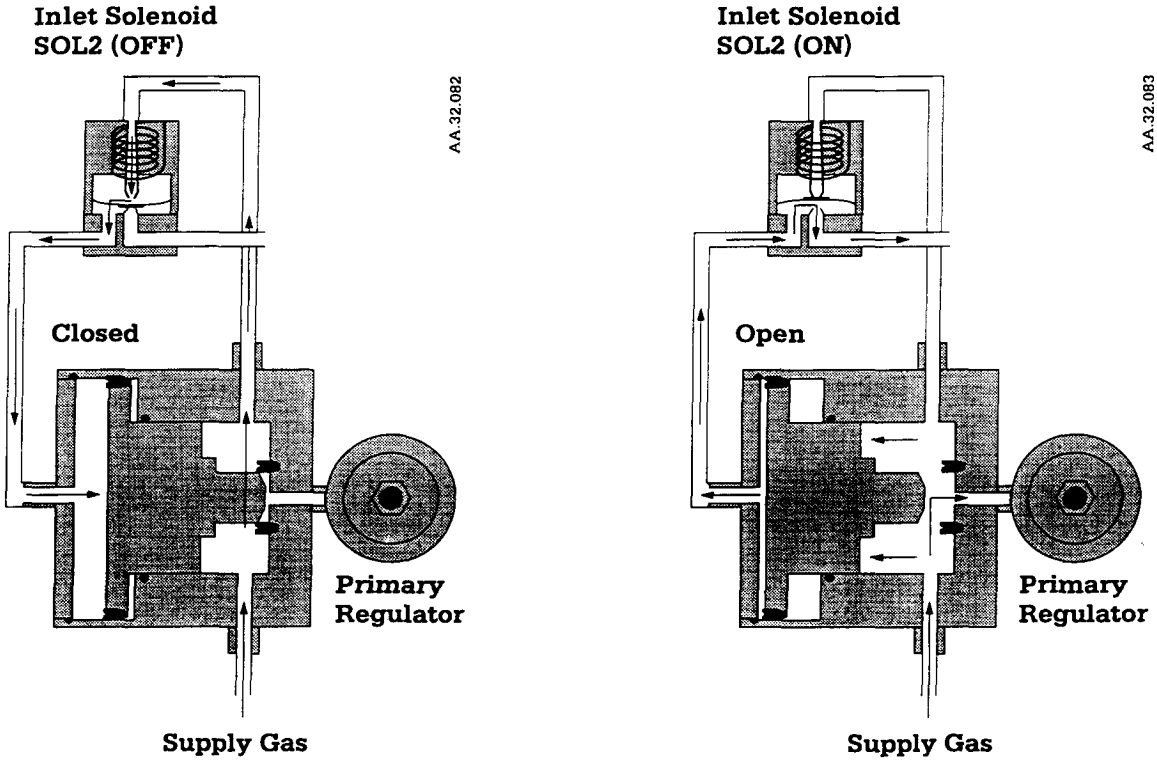


Figure 2-2 Inlet Solenoid and Gas Inlet Valve, OFF and ON

B. Pressure Regulation

The Ventilator has a Primary Regulator and a Secondary Regulator. The Primary Regulator is mounted next to the Gas Inlet Valve. Supply Gas enters the Primary Regulator directly from the Gas Inlet Valve. The Primary Regulator output connects to the Pneumatic Manifold Assembly which contains the Flow Control Valve. The output of the Primary Regulator also goes to a Secondary Regulator that further reduces the pressure. The output of the Secondary Regulator is used to inflate the Exhalation Valve.

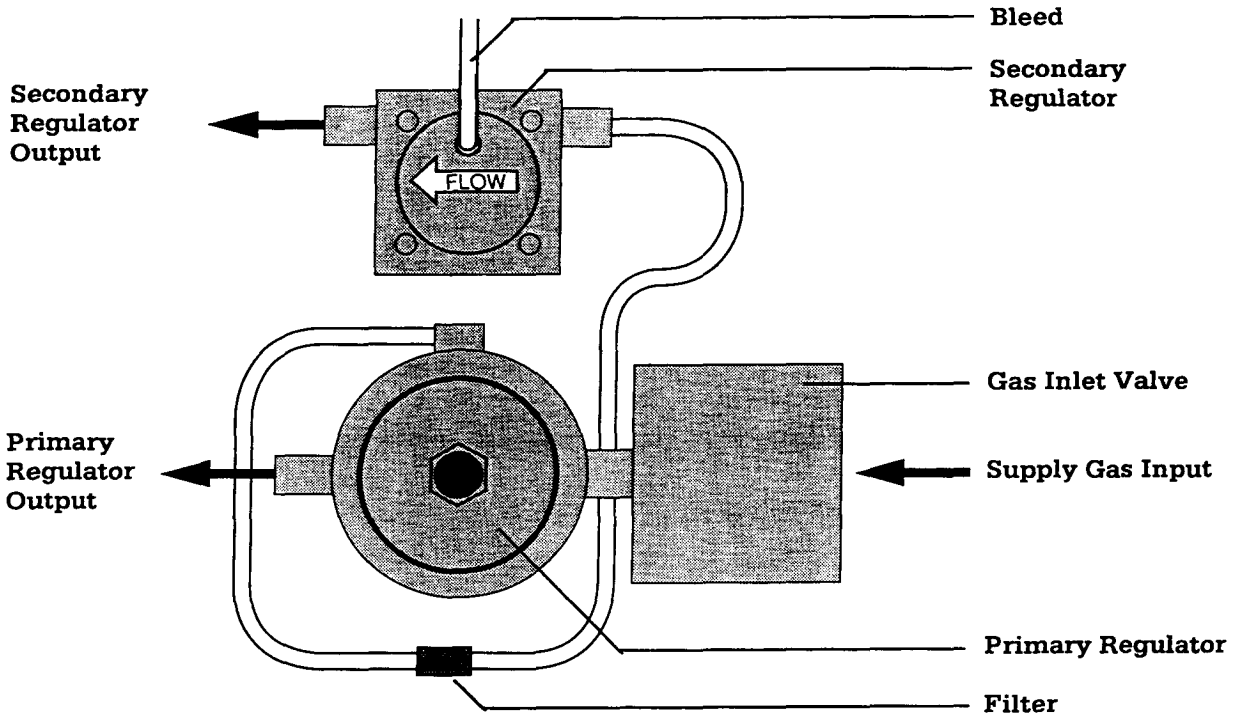


Figure 2-3 Primary Regulator and Secondary Regulator

C. Flow Control Valve

The drive for Inspiration is an increase in pressure applied to the breathing circuit. Ventilation Drive Gas flow is supplied by the Flow Control Valve. The precise amount and rate of Inspiration is accurately controlled by the microprocessor through a Digital to Analog converter. The microprocessor proportionally changes the Drive Gas flow by changing the current applied to the Flow Control Valve. If the power is removed the Flow Control Valve shuts OFF.

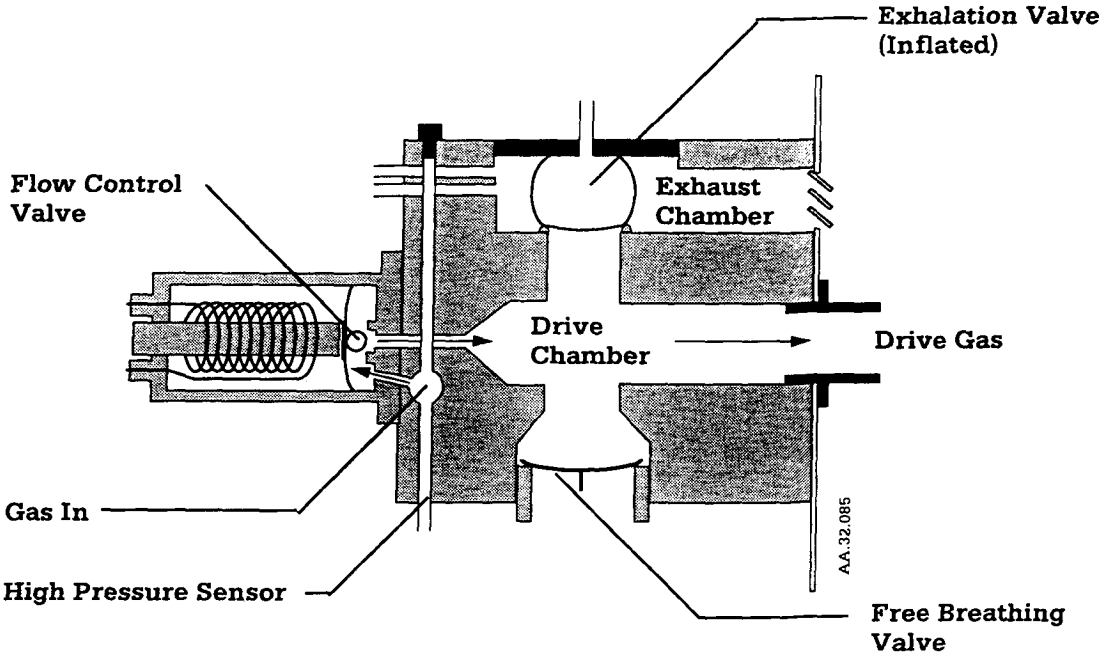


Figure 2-4 Pneumatic Manifold Assembly Inspiration

The Flow Control Valve releases positive pressure into the Drive Chamber. As gas enters, the Drive Gas pressure builds up in the Drive Chamber, through the flexible hose, and increases the pressure in the Bellows Assembly.

During the inspiratory phase of ventilation the Drive Gas increases the patient circuit pressure and, in combination with the duration, determines the tidal volume.

D. Exhalation Valve

The Pneumatic Manifold Assembly has an internal Exhaust Chamber. The Exhaust Chamber is open to atmosphere through the back of the Control Module. Note the louvers above the Drive Gas output on the rear panel. Exhaust gas from the two solenoids and the Secondary Regulator, is connected to the Exhaust Chamber and relieve directly to the atmosphere.
During the Exhalation phase, the Exhalation Valve is deflated and Drive Gas pressure is released to the atmosphere through the Exhaust Chamber.

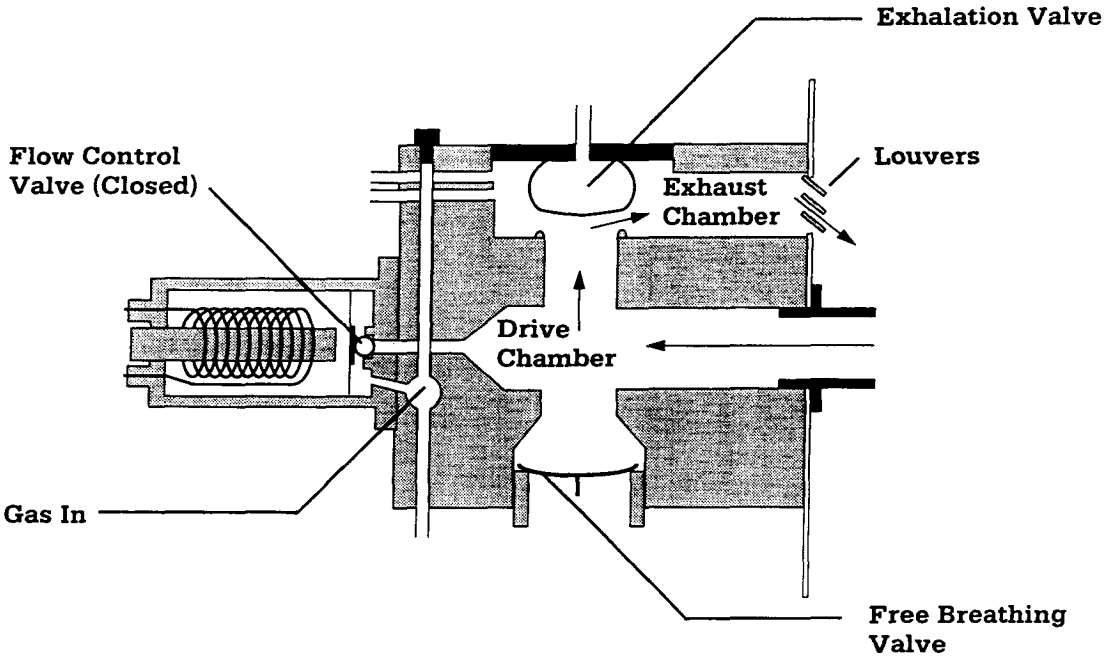


Figure 2-5 Pneumatic Manifold Assembly Exhalation

The Drive Chamber and Exhaust Chamber are separated by the Exhalation Valve. The Exhalation valve inflates, like a balloon, to seal OFF the opening.

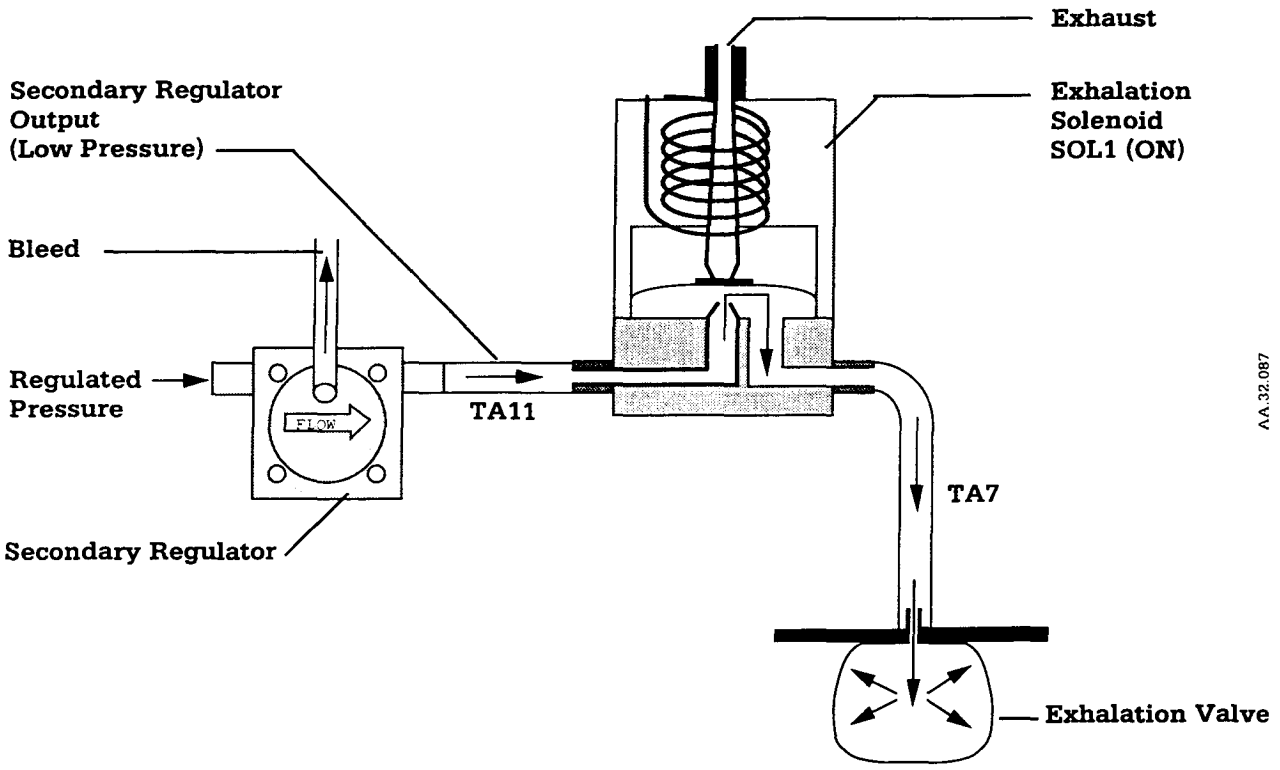


Figure 2-6 Exhalation Valve Inflating

During inspiration, positive pressure is held in the Drive Chamber by inflating the Exhalation Valve. Positive Pressure builds in the Drive Chamber, Drive Gas Hose and the outside chamber of the Bellows Assembly. The Flow Control Valve allows gas flow for the desired inspiratory time.

Approaching the end of inspiration the Flow Control Valve is turned OFF. If inspiratory pause (T_{IP}) is ON, the Exhalation Valve will remain inflated for an additional 25% of the set inspiratory time. The Exhalation Valve is deflated at the end of inspiration. This relieves the positive pressure in the Drive chamber and allows the drive gas in the Bellows Assembly to be vented through the Exhaust Chamber to the atmosphere.

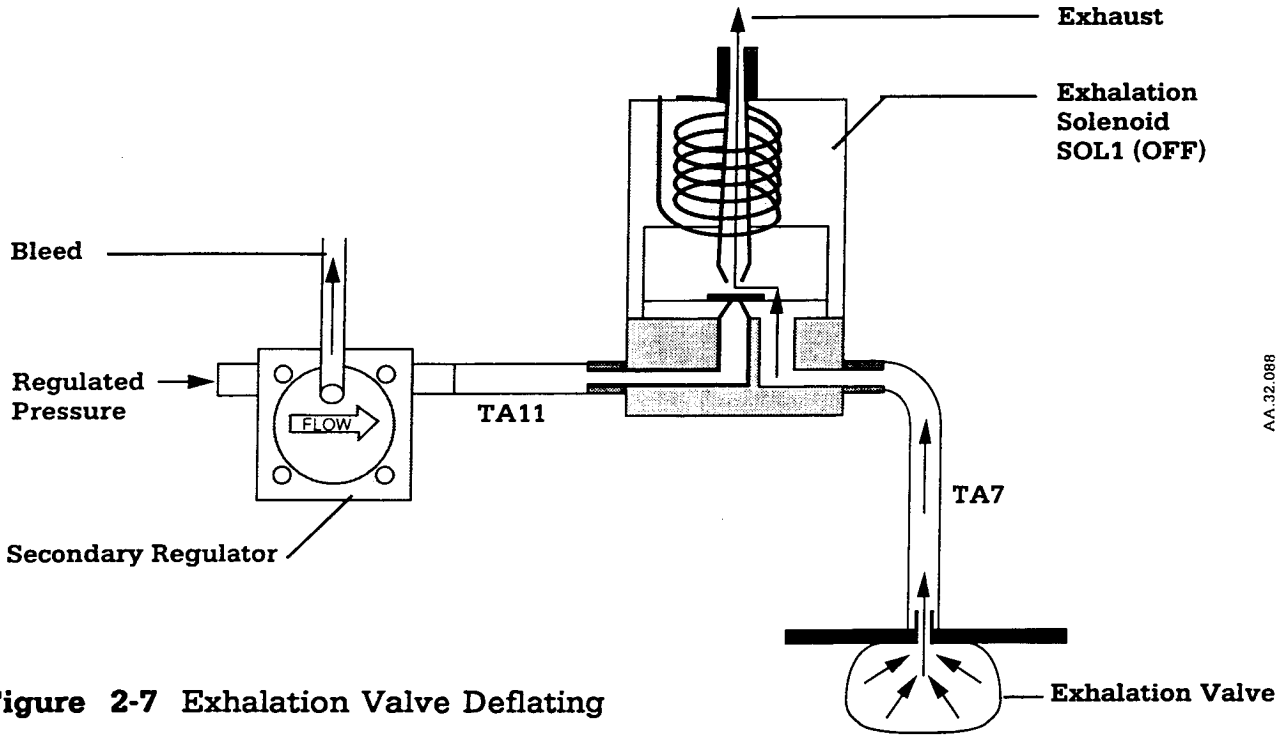


Figure 2-7 Exhalation Valve Deflating

E. Bellows

The Bellows isolates the Drive Gas from the Breathing Gas supplied by the Anesthesia Systems. At no time does the Drive Gas enter the patient Breathing Circuit.

During the inspiratory phase, the Control Module delivers Drive Gas into the area between the Bellows and the Bellows Housing. As the volume of gas increases, pressure is exerted on the Bellows which compresses. The Bellows in turn exerts pressure on the patient breathing circuit and the patient's lungs.

During the exhalation phase, the Drive Circuit Pressure is vented to the atmosphere. This reduction in pressure allows gas to flow from the patient breathing circuit into the Bellows. The Bellows rises within the Bellows Housing.

F. Pressure Relief Valve

The Pressure Relief Valve is located within the Bellows. This valve remains closed during inspiration. When the Bellows cannot extend any further during exhalation, the Pressure Relief Valve opens and the excess gas is vented through the exhaust tube. This will happen when the pressure in the patient circuit during exhalation exceeds the vented Driving Gas circuit pressure by 2.5 cm H_2O.

G. Free Breathing

The Free Breathing Valve acts as a check valve. Normally the pressure within the Drive Chamber and corresponding Bellows and Breathing Circuit is controlled by the Ventilator. If the patient attempts to inhale, a sudden drop in Breathing Circuit pressure occurs. If the Drive Gas flow is less than the demand, pressure within the Drive Chamber will drop, the Free Breathing Valve will open making up the additional volume with ambient air. This allows the patient to breathe spontaneously.

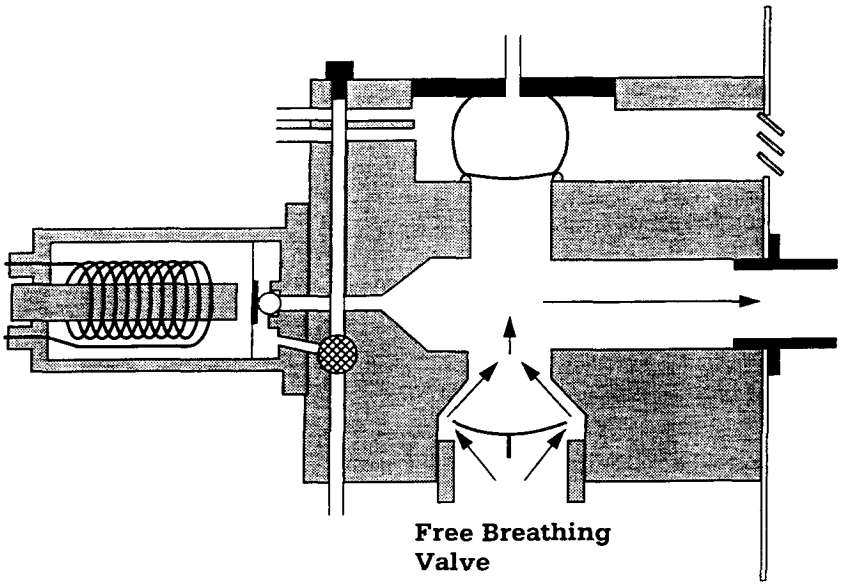


Figure 2-8 Free Breathing Valve

I. Filtering

Ventilators may have a replaceable five (5) micron inlet filter and water trap located before the Gas Inlet Valve.

A replaceable five (5) micron particulate filter is located between the Primary Regulator and Secondary Regulator.

A permanent coarse (150 mesh) screen filter is located where the gas enters the Pneumatic Manifold Assembly.

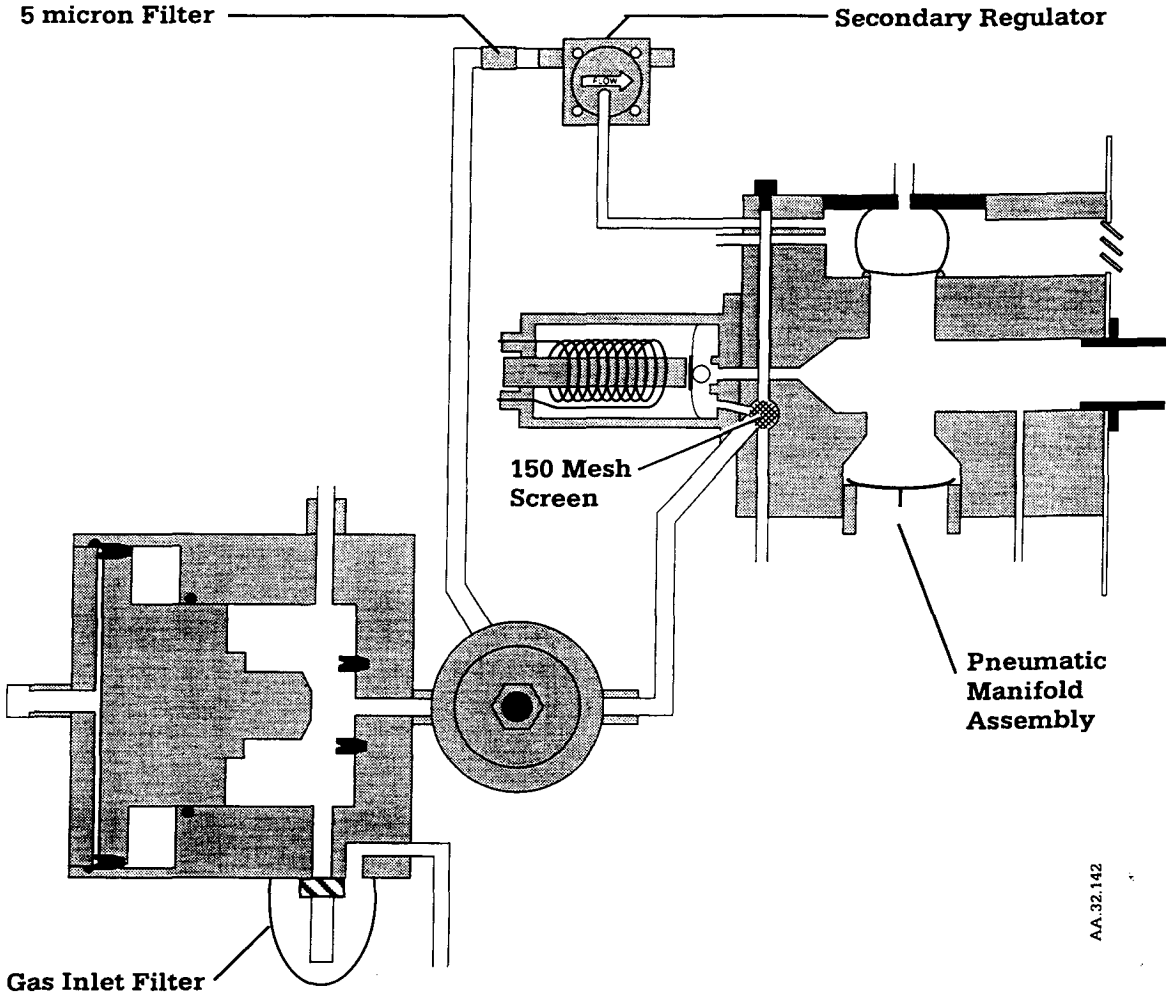


Figure 2-10 Pneumatic Manifold Assembly Filter

2.2 Electronic Descriptions

Notation Within this Text

Unless otherwise noted, all voltages are positive with respect to signal and supply ground.

A "/" indicates that for this signal is active (true) at a logic level of zero (0). Some examples are: /CS2, /RD, or /WR. This is often referred to as a "negative logic" or "active low" signal.

All voltages are designated as Direct Current "V dc" or Alternating Current "V ac." Voltages are also designated as positive "+" or negative "minus (-) ." Some examples are: "+ 4.37 V dc," or "minus (-) 4.37 V dc." Tolerances are expressed with an additional number: "5.25 ±0.01 V dc."

Current values are designated as Ampere "A dc", milliampere "mA dc" or microampere as "µA dc."

Component Designations

Component numbers are separated from pin numbers by a "–." Like this: "U124-2" or "J2-15." Additional pins are separated by a comma "U8-2,3" or "J10-7,8."

Typical Notation	Part
C178	Capacitor
CR124	Diode
F2	Fuse
FL1	Filter
J1, J15	Connector; jumper, jack or plug
K102	Relay
L103	Inductor
P1	Connector; jack or plug
R102	Resistor; fixed or adjustable
SW101	Switch
U124	Integrated Circuit

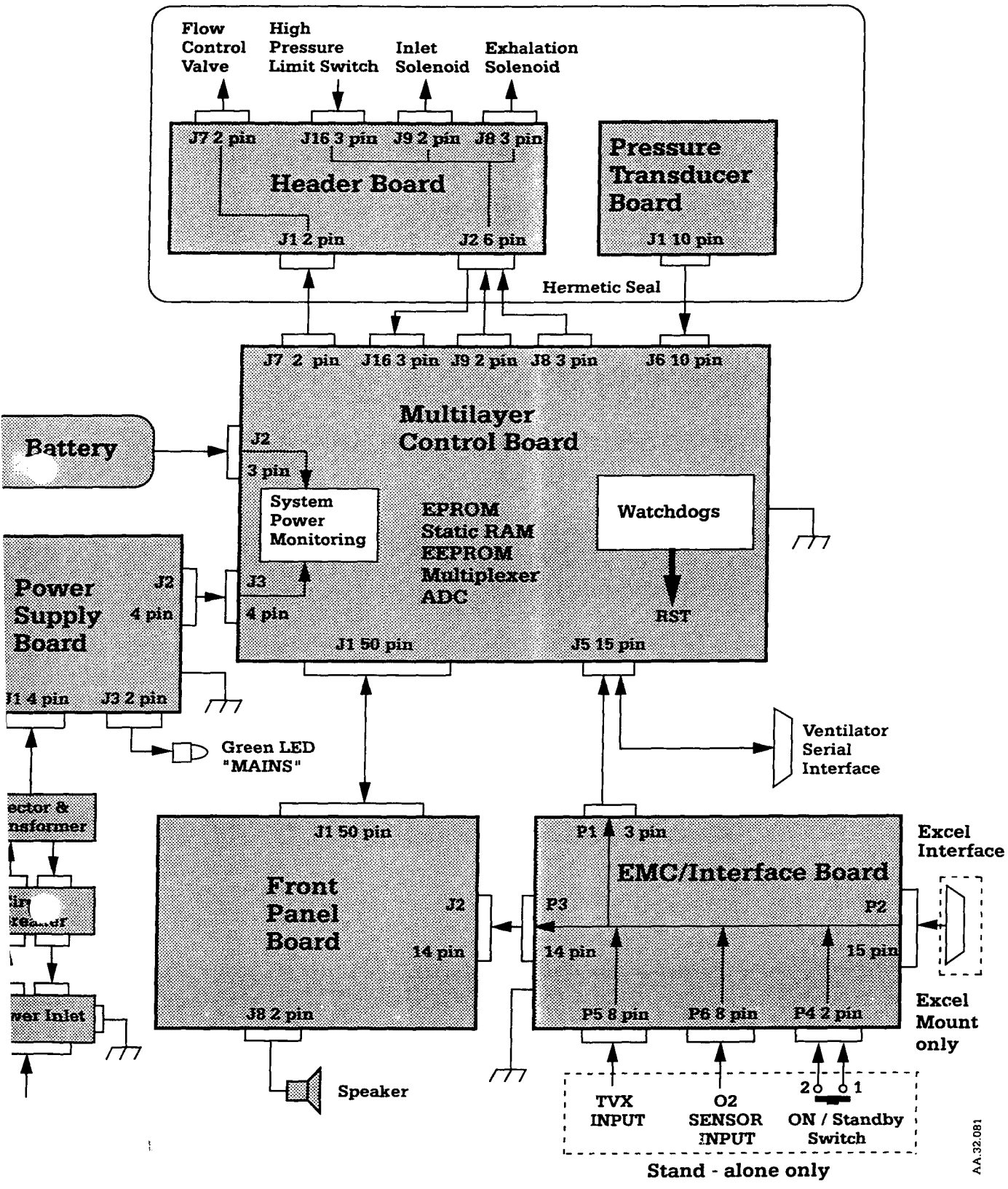


Figure 2-11 Block Diagram Electrical Connections.

A. Cordsets

Cordsets vary according to local requirements. The cordsets have an IEC 320 style connector at the Control Module end. The cordset is secured to the Control Module to prevent accidental disconnect.

B. Filter, Breaker, Selector, Transformer

The line cord connects directly to the power inlet electromagnetic interference filter, FLTR. The device filters interference going to and coming from the Control Module.

The output of the filter goes to a 0.5 A double pole circuit breaker, BKR. Excess line current, or neutral current, can cause this circuit breaker to open, disconnecting both inputs.

The transformer windings are selected by a multiple pole voltage selector switch (VSC). The combinations of windings provide for different selectable primary voltages (100, 120, 220, 240 V ac).

The transformer has internal thermal protection and will open the primary winding if the temperature reaches 150° C . The secondary of the transformer steps down to a center tapped 32 V ac .

C. Power Supply Board

The Power Supply Board converts a dc or ac input, to a +5.2 V dc, 3A dc power supply, using a step-down switching regulator configuration.

The ac input is supplied by a transformer secondary with a center tap connection.

The input voltage range is from 28.8 V ac (center tapped) minimum, to 48.0 V ac (center tapped) maximum, for a transformer rated at 42 VA.

Fuses F1, F2, and F3 provide fault protection in the event of a component failure on the Power Supply board..

U1 is an adjustable output, 3A dc step-down switching voltage regulator.

The combination of resistors R6 and R8 and potentiometer R7 provide a typical output voltage adjustment range of from +4.3 to +5.8 V dc.

U2 is a power supply supervisory circuit, used to monitor over and under voltage fault conditions. When a dc output voltage exceeding +6.17 V dc (typical) is detected for a period exceeding 125 microseconds (typical), U2-1 will go to logic 1, and cause crowbar SCR CR5 to conduct. Once SCR CR5 is turned ON, it will remain ON as long as input power is applied to connector J1; the voltage at J2-1 and J2-2 will be reduced to the forward drop of CR5 (0.8 V dc typical). When an unregulated voltage exceeding +36.6 V dc (typical) is detected for a period exceeding 1.25 milliseconds (typical), the open collector output U2-6 will turn OFF, and be pulled to a logic 1 by R11.

Resistors R3 and R4 provide a high impedance path from dc ground, to chassis ground. Capacitor C6, provides a high frequency path from dc ground to chassis ground, for electrical noise and electrostatic discharge. Chassis ground is tied to this circuit board through the heatsink on U1 .

Connector J3 supplies power to an LED whenever ac power is supplied to the Power Supply board. This LED may be used to indicate to the user that the Ventilator is energized by mains voltage.

D. Multilayer Control Board

1. Power Source Selection [Sheet 5 of schematic]

The + 5 Vdc power supply voltage is connected to the Control Board via J3-1,2 (+) and J3-3,4 (-). Fuse F102 limits current to 4A dc.

On the 7800, a backup battery pack is connected via J2-1 (+) and J2-3 (-).

Output U145-1 (PS OK) is high if the external supply voltage is greater than +4.58 ±0.09 V dc . If it drops below +4.58 ±0.09 V dc, K102 will switch ventilator supply voltage from the external supply to the battery.

Output U145-7 (BAT_OK) will be high if the battery voltage is above +4.37 ±0.06 V dc.

Headers J14 and J15 (jumpered, 7850 only) provide the capability of using the ventilator without an internal battery pack.

2. Auxiliary Supply [Sheet 5]

U138 is a step-up switching regulator that generates 9.65 ±0.39 V dc which is used for the battery charger and the TVX heater.

3. Battery Charger [Sheet 5]

U139 is an adjustable linear voltage regulator which provides current to charge the NiCad battery pack connected between J2-1 and J2-2 .

R229 and R282 limit the current delivered to the battery when it is fully charged.

4. TVX Heater Source Voltage [Sheet 5]

The TVX heater (external) consists of two 27Ω (½ Watt) resistors in series — located in the TVX clip. The TVX heater can be connected to the Front Panel board or J18 on the Control Board.

When connected to the Front Panel board, the TVX heater is powered from the +5 V dc, the heater current is sensed on the Front Panel board, and a sense signal is supplied to the Control Board through J1-9 (TVX SEN).

When the TVX heater is connected to J18-1,2 on the Control Board, it receives its power from the auxiliary supply (U138) and the heater current is sensed on the Control Board.

CR131 and CR118 provide two power paths for the auxiliary supply (U138). Power is supplied through CR131 during normal operation and is supplied through CR118 during backup operation.

5. System Power Up Relay [Sheet 5]

System power up relay K103 switches the VCC power source selected by K102, to the rest of the ventilator system. K103 can be energized by shorting jumper J4 on the Control Board or by connecting REMOTE+ to REMOTE- with a remotely located switch. VCC is routed to the digital circuits, to the flow, gas inlet, and exhalation valve control circuits, and also to the dc-dc converters.

6. +VA, -VA and VPPFLASH Switching Regulator [Sheet 5]

U143 and the associated components generate +VA, -VA and VPPFLASH. +VA is regulated to +8.3 ±0.3 V dc, -VA is regulated to minus (-) 8.3 ±0.6 V dc, and VPPFLASH is regulated to +17.0 ±1.6 V dc . The +VA and -VA supplies to the Pressure Transducer board are provided through connector J6.

7. VPPFLASH-Post Regulated Flash Programming Supply [Sheet 5]

The flash memory programming power supply (VPPFLASH) generates 12.0 ±0.6 V dc and delivers a minimum current of 30 mA.

8. E.L. Panel Driver [Sheet 5]

L108 is a dc-to-ac converter which develops 80 ±20 V ac at 700 ±100 Hz with an electro-luminescent panel connected to its output. R114 provides a means for adjusting the output voltage to the EL panel, affecting its brightness. J11 is for de-energizing the EL panel.

9. Power Up RESET and Program Flow Watchdog Timer [Sheet 3]

This watchdog circuit is designed to detect errant program execution as well as provide a watchdog time-out function. A negative reset pulse will occur at U128-3 if the circuit is not toggled in an appropriate time or if incorrect program execution is detected. The on-board audio alarm (BZ1) will sound when multiple consecutive errors have been detected.

U127 monitors the power supply voltage level and forces a system reset if a low VCC voltage error or out of limit condition is detected. The voltage trip point is set at 4.5 V dc maximum (4.37 V dc typical).

10. Too-Fast, Too-Slow Watchdog Timer [Sheet 3]

The watchdog timer U128 monitors the frequency of the microprocessor watchdog input U128-2 (WDOGIN) to detect processor too-fast or too-slow conditions. The watchdog timer will reset the microprocessor if either condition occurs.

11. 64 x 16 EEPROM [Sheet 1]

U114 is a 64 register by 16-bit Electrically Erasable Programmable Read Only Memory (EEPROM). All data transfer to and from the device is done serially.

12. Microcontroller Oscillator [Sheet 1]

X101, C104-C105, and the oscillator circuit in U104 form a 12 MHZ oscillator which provides the master clock for the 80C31 Microcontroller.

13. RS-232 Interface [Sheet 1]

U108 is a dual RS-232 receiver/transmitter. It contains two voltage converters which generate +10 V dc and (minus) -10 V dc from +5 V dc.

U108 contains four 4-level translators. Two of the level translators are RS-232 transmitters and convert TTL/CMOS input levels into +9 V dc and minus (-) 9 V dc RS-232 outputs. The other two level translators are RS-232 receivers which convert RS-232 inputs to +5 V dc TTL/CMOS output levels. A single transmitter and receiver are used. The output of the transmitter and the input of the receiver are connected to J5.

14. Microcontroller [Sheet 1]

U104 is a 80C31 CMOS 8-bit Microcontroller running at 12 MHz with:

- 128 x 8-bit RAM,
- 32 programmable I/O lines,
- two 16-bit timer/counters,
- 64K program memory space,
- 64K external data memory space,
- programmable serial port, and
- 5 interrupt sources.

Eight of the I/O lines are used for the multiplexed lower address/data bus and eight additional lines are used for the upper address bus.

The remaining port lines are used to:

- receive the TVX transducer interrupt,
- read the TVX transducer direction input,
- control the 32-channel multiplexer,
- send and receive data from the EEPROM,
- maintain the watchdog timer,
- send and receive serial communication,
- determine when an A/D conversion is complete,
- provide read and write signals for external data memory and mapped devices.

15. Address Decode [Sheet 1]

The 80C31 Microcontroller has separate 64K address spaces for program memory and external data memory. /RD and /WR control access to external data memory. /PSEN controls access to program memory. U101 and U146 determine which circuits will be accessed by the Microcontroller by decoding address lines A4 through A15 and generating the individual chip select signals (/CS1 through /CS7).

16. 64K x 8 Program Memory [Sheet 1]

U112 can be a 64K x 8-bit CMOS FLASH memory, or a 64K x 8-bit CMOS EPROM. The FLASH memory is a 32 pin Dual-Inline-Package (DIP); the EPROM is a 28 pin DIP. For compatibility, the EPROM must be placed in the 32-pin socket so that pin 1 of the IC is placed in position 3 of the socket.

17. BUS TRANSCEIVER [Sheet 1]

U110 is an octal bus transceiver. It provides buffering and direction control.

18. 8K x 8 Static RAM [Sheet 1]

U102 is an 8K x 8-bit CMOS static Random Access Memory.

19. Address Latch [Sheet 1]

U111 is an 8-bit address latch used to de-multiplex the lower address lines from the address/data bus.

20. 8-BIT Output Port [Sheet 3]

U132 is an 8-bit output port.

Pin	Signal	Function
U132-12	EE_CLK	Clock for EEPROM
U132-13	EEPCS	Select line for EEPROM
U132-14	TVXHTRON	TVX heater, control line
U132-15	SUP_VAL	Inlet Solenoid, control line
U132-16	YELLED	Front Panel, Yellow LED, control line
U132-17	REDLED	Front Panel, Red LED, control line
U132-18	EX_VAL	Exhalation Solenoid, control line
U132-19	CHRG	Battery Charger, control line

21. 8-BIT Input Port [Sheet 3]

U133 is an 8-bit input port. Inputs are from 7 DIP switches used to select feature options on the ventilator and an external alarm silence signal.

U134 is an 8-bit input port

Pin	Signal	Function
U134-2	BRD_ID_0	J102 not installed = 0, J102 installed = 1
U134-3	BRD_ID_1	J103 not installed = 0, J103 installed = 1
U134-4	BRD_ID_2	J104 not installed = 0, J104 installed = 1
U134-5	OVR_PRES	fault=1; pressure exceeded high limit
U134-6	UDER_VLT	fault=0; VCC below 4.6 V dc
U134-7	OVER_VLT	fault=0; VCC above 5.4 V dc
U134-8	TVXHTRON	TVX=1, heater is ON; TVX=0, heater is OFF
U134-9	PROT_REG	EEPROM protect register control line

22. Voltage Reference [Sheet 2]

U120 is a precision reference that generates a +2.5 V dc reference for the VCC overvoltage/undervoltage monitor circuit (sheet 4) and the Flow Control Valve drive circuit calibration (sheet 4). U121-2,3,6 amplifies this reference to a +4.5 V dc reference used for A/D and D/A conversion. U113-8,9,10 forms a voltage follower circuit, which buffers the +4.5 V dc and goes to J6-1 (Pressure Transducer board). U115-8,9,10 provides a buffered reference for use on J1-11 (Front Panel board) and the Test Connector J10-7.

23. Patient Pressure Analog Output [Sheet 2]

One half of dual 8-bit latched multiplying DAC U105 (DAC A) along with C118 and U113-1,2,3 generates a voltage which can be controlled by the Microcontroller. The circuit is designed so that a 0 code latched into DAC A will generate 0 V dc, while an 8CH code (140 decimal) will generate +1 V dc (One LSB = 1 cm H_2O).

24. Flow Control Valve [Sheet 2 & 4]

The second half of DAC U105 (DAC B) along with U113-5,6,7 and related components generates another voltage which can be controlled by the Microcontroller. The signal at U137-1 can be varied between 44.2 mV dc and 0.0 mV dc with a 0 code input to U105, DAC B and varied between +245 mV dc and +409 mV dc with a 0FFH code input to DAC B.

25. Flow Control Valve Drive / Sense [Sheet 4]

U137-1 (DAC_FLOW) is tied to the input of the differential amplifier U137-6 . The differential amplifier generates the difference between VCC and DAC_FLOW at U137-7 . This voltage is applied to U137-10, the input of the voltage to current converter. The current to pass 100 L/min through the Flow Control Valve is nominally 1200 mA dc.

The output of U137-8 is connected to Front Panel switch SW108. This interlocks the Flow Control Valve drive circuit with the Mechanical Ventilation switch. If the switch is open, the Flow Control Valve is shut OFF regardless of the voltage at U137-8 .

U137-12,13,14 amplifies the sense voltage. This voltage is connected to one channel of the A/D converter for sensing correct drive circuit operation.

U135-4,5,6 provides an additional interlock which keeps the Flow Control Valve OFF if the Exhalation Valve is ON.

26. Oxygen Analog Output [Sheet 2]

One half of dual 8-bit latched multiplying DAC U103 (DAC A) generates a voltage which can be varied by the Microcontroller. A 0 code latched into DAC A will generate 0 V dc, while a C8H code (200 decimal) will generate +1 V dc on U115-1 (One LSB = 0.5% O_2).

27. LCD Contrast Driver [Sheet 2]

One half of dual 8-bit latched multiplying DAC U103 (DAC B) generates a voltage which can be varied by the Microcontroller. The circuit is designed to generate 0 V dc to (minus) - 4.5 V dc, depending on the value latched into DAC B. This output is connected to the Front Panel board and is used to vary the contrast of the Liquid Crystal Display.

28. A/D Converter [Sheet 2]

U117 is a CMOS 10-bit Analog-to-Digital converter with a conversion time of 50 µS (typical). The full scale input voltage is set to +4.500 V dc at U117-9 .

29. 32-Channel Multiplexer [Sheet 2]

U116, U119, U122 and U123 are CMOS single 8-channel analog multiplexers. Together they form a 32-channel multiplexer. The Microcontroller uses signals /MUX1, /MUX2, /MUX3, MUX4, MUXA, MUXB, and MUXC to select a specific multiplexer channel.

30. System OK / Valve Interlock [Sheet 4]

Gates from U131 and U135 form an interlock for the Exhalation Valve (which also interlocks the Flow Control Valve). RST (the watchdog circuit reset) must be low and PS_OK or BAT_OK from the power source selection circuit must be high in order for SYS_OK to be high. SYS_OK is also ANDed with EX_VAL and if SYS_OK is low, the Exhalation Valve will not turn ON. SYS_OK is also sent to the Front Panel board to force a system fail response if it goes low.

31. Exhalation Valve Drive and Sense [Sheet 4]

Operational amplifier U136-1,2,3 and Q104 acts as a current limited high side driver. The voltage at U136-7 (EXHSENS) may be monitored by the controller through one channel of the A/D converter U117 (sheet 2).

A normally open (NO) pressure sense switch is connected between J16-1,3 . If the pressure sensed by the switch rises to 105 ±5 cmH_2O, the switch closes. This de-energizes K101, disconnecting the Exhalation Solenoid valve. K101 will latch itself OFF until EX VAL is driven low. This provides a high pressure safety relief in the event that the patient pressure sensing circuit of the Ventilator is inoperative.

32. Gas Inlet Valve Drive and Sense [Sheet 4]

Operational amplifier U136-8,9,10 and MOSFET Q106 forms a current limited high side driver for the Gas Inlet Valve. It operates the same way as the Exhalation Valve. The Inlet Solenoid is normally ON throughout Ventilator operation. The voltage at U136-14 (GIVSENS) may be monitored by the controller through one channel of the A/D converter U117 (sheet 2).

E. Front Panel Board

1. System Fail Logic

SYSOK is generated by the Control Board and is high if the Power Supply and watchdog circuits are functioning correctly. If a failure occurs, SYSOK turns OFF the red LED, and turns ON the yellow LED. The Liquid Crystal Display also goes blank and the audio alarm section activates.

2. LED Alarm Indicators

The red LED (CR31) and the yellow LED (CR32) located on SW109 are driven by transistors Q6 and Q5 respectively. Transistor Q6 is controlled by REDLED and Q5 is controlled by YELLED from the Control Board.

3. Liquid Crystal Display

The Liquid Crystal Display Module is connected to the Front Panel board at J5. It is an intelligent device that receives commands and data from the microprocessor on the Control Board.

VEE is the display drive voltage which is controlled by V_DISP, generated on the Control Board. Liquid Crystal Display contrast is related to the voltage difference between VCC (J5-2) and VEE (J5-3). Diodes CR1-CR4 and CR23-CR25 provide a voltage change with temperature of about minus (-)9.5 mV dc/°C. This closely matches and balances the temperature sensitivity of the Liquid Crystal Display.

An electro-luminescent panel is contained in the Liquid Crystal Display. An ac voltage of 80 ± 20 V ac rms at 700 Hz ±100 Hz, powers the EL panel. The ac voltage comes from the Control Board (J1), and goes to the Liquid Crystal Display.

4. Front Panel board Input

U110 functions as an 8 bit input port. The Front Panel switch matrix, touch detection circuit, and variable frequency audio alarm are input to the processor through this port.

5. Front Panel Switches

The following switches are wired in a 4 x 7 matrix:

- Pushwheel Assembly (Low MV, Low O_2, High O_2) ---------- SW102-SW107
- Alarm Reset switch ---------- SW109
- Mechanical Ventilation switch ------ SW108
- Inspiratory Pause switch ---------- SW110
- Future Switch Expansion ---------- (J9)

The pushwheel format is BCD (Binary Coded Decimal).

6. TVX (Volume) Transducer Input

The TVX Volume Transducer (connected at J2) provides two input signals in the form of pulse trains PULSE A and PULSE B. The frequency of each signal is proportional to the amount of gas passing through the transducer.

When flow is in the expiratory direction (direction indicated on the label on the transducer clip), PULSE B leads PULSE A. When flow is in the opposite direction, PULSE B lags PULSE A.

R106 is connected in the return line of the TVX clip heater when the clip is plugged into J2 . The voltage generated across R106 is used to sense if the TVX clip is plugged in.

7. Oxygen Sensor Input

The oxygen sensor (connected at J2) generates a current which is proportional to the partial pressure of oxygen in the sample gas. Two cells may be present in the sensor but only a single cell, SENSOR_A input, is used. The load presented to this cell is 617 ohms at 25 °C. The other cell, SENSOR_B input, is shunted to ground.

Note: The oxygen sensor should be shunted to ground through a load resistor at all times for proper operation. Leaving a sensor open-circuited causes oxide to develop on the cells. When the cell is later reconnected it may take several hours before normal operation of the cell resumes.

Calibration of the circuit is done via software using a gain value derived from the oxygen calibration potentiometer (R80) setting.

8. Control Potentiometers

R101-R103 and R105 are the Front Panel potentiometers used to set values for tidal volume, respiratory rate, inspiratory flow, and inspiratory pressure limit used by the Ventilator. Each potentiometer has 270 degrees of mechanical travel range. Appropriate scaling is done in the software.

9. Audio Alarm

Two sections of the quad op amp U112 are used to generate +0.95 V dc and minus (–) 0.95 V dc voltages from the reference +4.500 V dc supply. These voltages are used in the audio alarm circuit.

One half of the dual 8 bit DAC U111 controls the frequency of a square wave oscillator. The other half of DAC U111 controls the gain of the square wave signal. If $\overline{\text{SYSOK}}$ is low, this signal drives the speaker connected to J8.

A CMOS 555 timer, configured as an oscillator, generates an approximately 1 kHz waveform. If $\overline{\text{SYSOK}}$ is high this signal, instead of the microprocessor generated signal, drives the speaker.

10. Touch Detection Circuit

There are three identical touch detection circuits, one each for the Tidal Volume, Rate and Inspiratory Flow setting knobs on the Front Panel.

The knobs have a conductive front surface which is electrically connected to the Front Panel circuit board. Capacitors dc isolate the knob from the rest of the circuit.

A 500 kHz oscillator is connected to the detection circuit. The circuit operates by using body capacitance (about 30-100pF) to lower the impedance to ground and reduce the amplitude of the 500 kHz signal. The signal is fed to a peak detector which outputs a signal equal to the difference at its inputs as the knob is touched. This signal is amplified for maximum gain without false triggering from noise. The output signal is low when the knob is not being touched. The output signal is high when the knob is first touched. The signal falls low again after about 1 second, as the low pass filters respond.

11. Flow Control Valve Interlock

One half of the mechanical ventilation ON/OFF switch (SW108) is connected so as to interrupt the control loop on the Control Board which drives the Flow Control Valve. If SW108 is OFF (open), the control signal is disconnected, forcing the Flow Control Valve OFF.

F. Pressure Transducer Board

1. Power Supply

Power is supplied to the board via connector J1-6 (+8.30 ±0.35 V dc), J1-5 [minus (-) 8.3 ±0.60 V dc], J1-7,8 (analog ground) and J2-1 (chassis ground).

2. Voltage References

U7 is a +2.5 ±0.005 V dc voltage reference with a 25 ppm/°C maximum temperature coefficient.

The +2.5 V dc reference drives amplifiers U6A and U6B which generate the +5 V dc and minus (-) 5 V dc references. These references are used as power supplies for pressure transducers U4 and U5 and their offset adjustment circuits.

The +2.5 V dc reference is also used to generate a fixed +0.872 ±0.03 V dc temperature output reference at J1-4 .

3. Patient Pressure Circuit

U5 is a temperature compensated silicon piezoresistive gauge pressure transducer.

The offset adjustment R102 is used to set a positive zero pressure output voltage. This positive offset allows the circuit to measure negative pressures.

The gain adjustment R101 is used to set the full scale output voltage.

4. Supply Pressure Circuit

U4 is a temperature compensated silicon gauge pressure transducer (output, J1-3).

Potentiometer R103, R18 and R19 provide an offset adjustment to compensate for circuit offsets.

G. Header Board

The Header board is an interconnection between the cables coming from the Control Board and the cables for the components mounted on the Pneumatic Mounting Plate assembly. There are no active components on this board.

H. EMC/Interface Board

The EMC assembly is the interface between the Ventilator internal electronics and the sensors. The circuit includes EMI filters and bipolar transient suppressors (transorbs). The EMI filters attenuate electrical noise from Electrosurgical units or other electrical noise generators in the operating room environment. The transorbs protect the EMI filters and the signal input circuitry on the Control Board. The filters and transorbs use the chassis ground as common. High frequency noise is shunted away from the signal lines.

3.0 Post-Service Checkout

After servicing the Ventilator, you must complete section "4/Tests and Calibration." You must also complete the Ventilator checkout procedure for the entire system, the Ventilator, the Anesthesia System, and all the accessories and options.

⚠WARNING: You must perform all post-service checks after maintenance or service of the Ventilator. Malfunctioning equipment can result in serious patient injury.

⚠WARNING: All components and accessories must be connected correctly. All hoses and cables must be properly connected before returning the Anesthesia System to clinical use. Failure to do so may result in patient injury.

1. Test the Ventilator.

Perform section "4/Preoperative checkout procedure" found in the:

7800 Ventilator
International Operation and Maintenance Manual
Software revision 4.xx

2. Test the Anesthesia System.

The Ventilator is an integral part of a complete Anesthesia System. To be certain the Ventilator is functioning perfectly it is necessary to test the entire system. Please refer to the Anesthesia System manuals.

Important: If you have an Ohmeda Excel Anesthesia System, complete the system checkout procedure in the Excel Service Manual.

3. Test all Options and Accessories.

Complete the checkout procedures for all options and accessories included with the Anesthesia System.

4.0 Overview

⚠WARNING: Do not perform testing or maintenance on medical instruments while they are being used to ventilate a patient, possible injury may result.

This section includes failure identification tests and calibration procedures for the Bellows Assembly and the Control Module.

Testing Requirements

If you service only the Bellows Assembly, and do not remove the Control Module cover, it is not necessary to perform the Control Module Tests. Or, if you service only the Control Module, and do not disassemble the Bellows Assembly, it is not necessary to perform the Bellows Assembly tests. If you are performing routine maintenance it is necessary to complete the entire section. It is always necessary to perform section "3/Post Service Checkout" after this section.

⚠WARNING: Post-Service Checkout required after you complete this section. You must perform section " 3/Post-Service Checkout" after performing any maintenance, service or repair procedure. Patient injury could result.

Viewing Displays in Another Language

This manual illustrates ventilator displays in English. The ventilator language selection will determine which language you will actually see. In most cases the displays will be in the local language. You may choose to view the displays in English (by changing the language selection) or you can view the displays in your own language. Change the language setting back to the original language after testing is complete.

Note: The altitude and language selection are described in the Operation and Maintenance manual.

[redacted]

4/Tests and Calibration

4.1 Bellows Assembly Tests

These tests can be used to test both the Autoclavable Bellows Assembly (ABA) and the Non-Autoclavable Bellows Assembly (Non-ABA). Autoclavable parts are identified with the **"134°C"** marking.

Important: The ABA is completely customer maintainable. The end user can disassemble, repair, clean and test the ABA. However, service of the Non-ABA must be performed by a trained service representative.

A. Visual Inspection

1. Disassemble the Bellows Assembly. For more information refer to the Operation and Maintenance manuals.

⚠WARNING: On the ABA, do not remove the seat from the Diaphragm.

2. Carefully inspect each component for proper fit, signs of wear, deterioration or damage such as cracks, warpage, swelling or other physical changes, and replace as necessary. It is normal for the ABA Bellows and other rubber goods to change color somewhat from steam autoclaving.

⚠WARNING: Non-ABA components can not be autoclaved. Non-ABA components that have been autoclaved must be replaced before the system can be returned to clinical use.

3. Reassemble the Bellows Assembly and connect back into the Anesthesia System.

B. Bellows Assembly Pressure Leak Test

This test checks the Bellows Assemblies for leakage under pressure by using the Breathing System pressure gauge and the Anesthesia System flow meters.

Tools Required:

- Ohmeda approved Test Plugs, two (2)
- Anesthesia O_2 flowmeter
- Breathing System pressure gauge
- Breathing System, complete

Overview

First, the entire Breathing System leakage is determined with the Bellows Assembly removed from the circuit. Then the test is repeated with the Bellows Assembly included. The difference between the readings is the Bellows Assembly leakage. The test is done at a pressure of 60 cm H_2O. The Bellows Assembly leakage must not be more than 250 mL/min for ABA, and 300 mL/min for Non-ABA.

Important: The Breathing System leakage rate may be less than the minimum O2 flow limit, particularly with new systems.

Leakage, without Bellows Assembly

1. Set the Breathing System to bag mode, which bypasses the Bellows Assembly. If you have an Ohmeda GMS Absorber, move the switch to "Bag/APL."

2. Remove the breathing bag and occlude the port. Remove any gas sampling adapters and tightly cap connections.

3. Close the APL valve. Turn OFF any other device that may cause this circuit to leak at 60 cm H_2O. If necessary consult your Breathing System operation manuals.

4. Turn ON the Anesthesia System and adjust O_2 to the minimum flow. All other gasses OFF.

5. Watch the pressure gauge and occlude the patient connection port ("Y" piece). Quickly unplug the port if the pressure approaches 100 cm H_2O. Ignore or silence alarms.

6. Slowly increase the O_2 flow until the pressure approaches 60 cm H_2O. Quickly reduce the flow until the flow equals the leak rate. Note the O_2 flowmeter reading. This flow is the Breathing System leak rate without the Bellows Assembly.

If you can not maintain the pressure at 60 cm H_2O and the pressure continues to increase with the lowest flow setting, then the Breathing System leak rate is less than the minimum O_2 setting.

7. Remove the patient connection port occlusion. Return the O_2 flowmeter to minimum flow. Remove the breathing bag occlusion and attach the breathing bag.

Leakage, with Bellows Assembly

8. Set the Breathing System to Ventilator mode (Bag/APL switch to "Ventilator"). Disconnect and occlude the 17 mm Drive Gas hose at the back of the Ventilator Control Module.

9. Watch the pressure gauge and occlude the patient connection port ("Y"piece). Quickly unplug the port if the pressure approaches 100 cm H_2O. Ignore or silence alarms.

10. Slowly increase the O_2 flow until the pressure approaches 60 cm H_2O. Quickly reduce the flow until the flow equals the leak rate.

11. Note the O_2 flowmeter reading. This reading must not be more than 250 mL/min for ABA (or 300 mL/min for Non-ABA) above the Breathing System leak rate. If the leak rate is too high correct the cause and repeat this test.

⚠**CAUTION: An unacceptable leak rate requires repair. Do not return the Bellows Assembly to clinical use until the leak is corrected.**

12. Remove all occlusions made in the Breathing System during this test. Remove the patient connection port occlusion. Remove the Drive Gas hose occlusion and connect the hose to the Ventilator.

Troubleshooting Leaks

Disassemble the Bellows Assembly and check the fit of all of the components (except the Non-ABA Pop-off valve, which can not be repaired in the field). The U-cup seal, Waste Gas Valve, Base and tubing are the most likely parts to leak. Systematically replace these components until the leak is corrected. Perform the test again.

C. Bellows Retention Test

This tests the Bellows retention, under pressure, by using the Breathing System pressure gauge and the Anesthesia System flow meters.

1. Occlude the patient connection port ("Y" piece) ,and exhaust (Gas Scavenger) outlet.

2. Use the Oxygen Flush button to inflate the Bellows to the top of the Housing. Using the O_2 flow valve, increase the pressure to 15 cm H_2O as read on the Breathing System pressure gauge. The Bellows must remain on the securing rim.

If the Bellows slips off, the Bellows must be replaced.

3. Remove all occlusions and reconnect any hoses that have been removed.

D. Additional Bellows Assembly Tests

If you have not removed the Control Module cover, it is not necessary to perform the Control Module Tests. Go directly to section "3/Post Service Checkout" if you have NOT serviced the Control Module.

⚠WARNING: Section "4/Test and Calibration" must be performed whenever you remove the Control Module cover, to verify that all critical parts of the Ventilator are still operational and within specification.

⚠WARNING: You must perform section "3/Post-Service Checkout" before returning the Ventilator to service. Failure to do so could result in injury to the patient.

4.2 Control Module Tests

A. Power Supply Test

Tools Required: Multimeter (4-½ digit)

Preparation: Remove the cover and swing the Control Board up.

1. Power ON the Ventilator.
2. Locate J10, the "TEST" connector, on the Control Board.

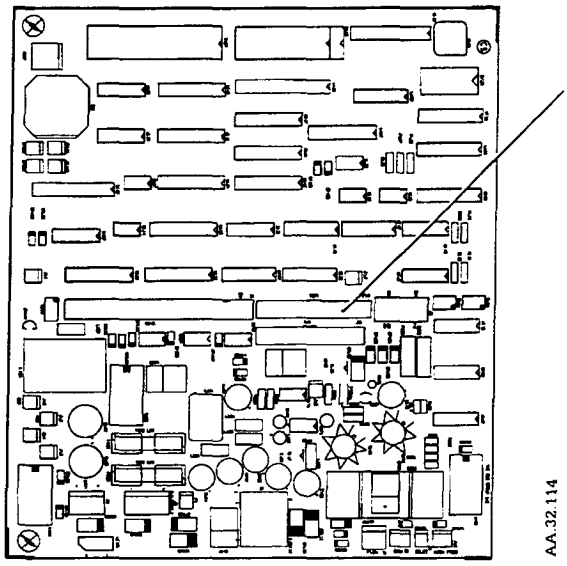
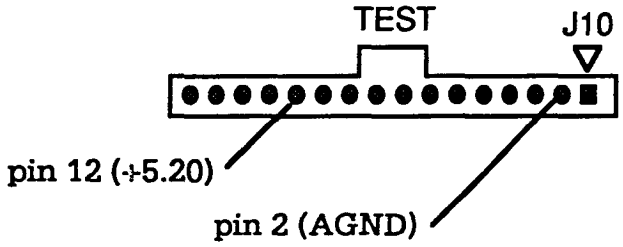


Figure 4-1 Control Board, TEST Connector J10

3. Measure between J10, pin 12 and pin 2 (AGND) on the Control Board (+5.20 V dc, + 0.10, -0.15 V dc).

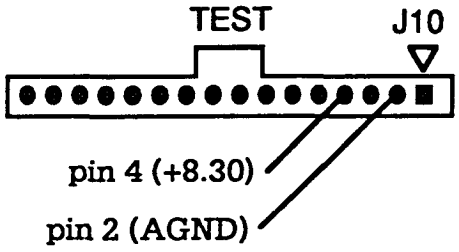


If out of range:

a. Remove the Lower Shroud and adjust the voltage through the small hole in the power supply board box.

b. If not adjustable, replace the power supply board.

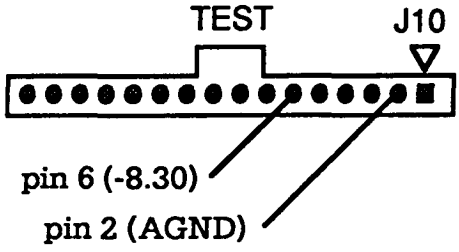
4. Measure between J10, pin 4 and pin 2 (AGND) on the Control Board (+8.30 ± 0.35 V dc).



If out of range:

   a. Disconnect the ribbon cable to J6 (on the Control Board) and check the voltage again.
   b. If now correct, replace the Pressure Transducer Board.
   c. If still NOT correct, replace the Control Board.

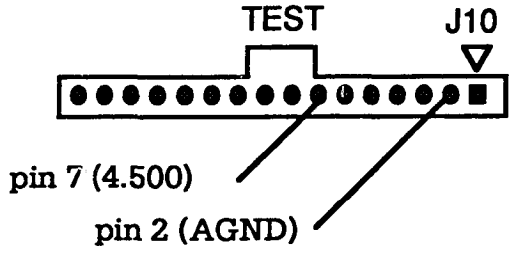
5. Measure between J10, pin 6 and pin 2 (AGND) on the Control Board (-8.30 ± 0.60 V dc).



If out of range:

   a. Disconnect the ribbon cable to J1 (on the Control Board) and check the voltage again.
   b. If now correct, replace the Front Panel.
   c. If still NOT correct, replace the Control Board.

6. Measure between J10, pin 7 and pin 2 (AGND) on the Control Board (4.500 ± 0.008 V dc).



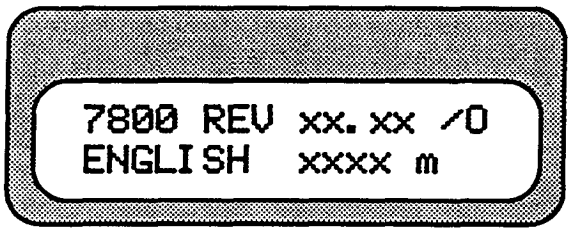
If out of range: replace the Control Board.

B. Checking User Parameters

Important: These settings are saved even when the system is powered OFF. It is necessary to set these parameters when the EEPROM has been replaced.

To Check User Parameters

1. Move the Mechanical Ventilation switch to OFF.
2. Electrically power ON the Ventilator.
3. Hold down the Alarm Silence button ⊠, and press the Inspiratory pause button.



If you do not see this screen: check the Control Board DIP switch SW101. Switch 1 must be ON and 2, 3, and 4 OFF to access the user selected parameters. This is the setting for operational mode.

This screen includes the following information:

The Ventilator Model: 7800

If not 7800: check the battery connector. The battery is not being recognized.

The Software Revision Number: REV xx.xx

The Supply Gas: /O

/O = Oxygen Supply Gas, /A = Air Supply Gas, and /E indicates an Error or no Supply Gas selection has been made.

The Language Selection: ENGLISH

The Altitude: xxxx m

The language selection and altitude selection are described in the Operation and Maintenance manual.

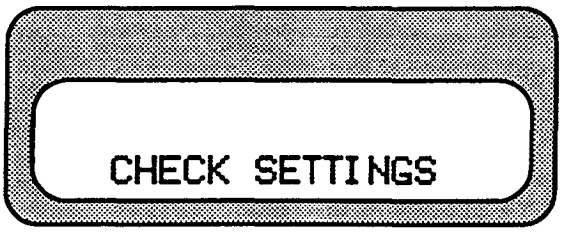
Record for future reference:

- Ventilator Model 7800
- Software Revision Number xx.xx
- Supply Gas selection O_2 or AIR
- Language _____
- Altitude xxxx meters.

Repeatedly press the Alarm Silence button and record for future reference:

- Reverse Flow Alarm ON or OFF
- SIGH ON or OFF
- Contrast number xx
- Audio Volume number xx.

Press the Alarm Silence button.



The Ventilator will return to operational mode.

C. Service Calibration Mode

Tools Required:

- Pressure Gauge, 0-150 cm H_2O
- Pressure Gauge, 0-400 kPa
- Digital Multi-Meter, 4 1/2 digit
- Squeeze bulb and valve
- Stopwatch
- Respirometer
- Adjustable pressure source (135 ± 5 cm H_2O)

The Service Calibration routines perform electronic and pneumatic checks on the Control Module. Each check begins with a special display screen. Not all screens require action.

You must step through the checks sequentially. After completing each check, press the Alarm Silence button ⊠ to enter the next check in the sequence.

Do not turn OFF the Ventilator during these routines. Service Calibration can only be started from step 1.

1. Check the Watchdog Timer

a. Power ON the Ventilator if not already powered ON.

b. Move the Control Board DIP switches (SW101) 1 OFF, 2 ON, 3 ON, 4 OFF.

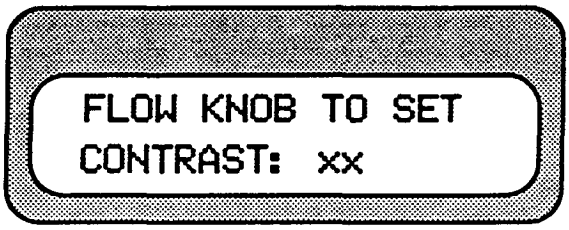
This reset sequence occurs:

- You will hear a long (1kHz) beep,
- followed by repeating short and long (1kHz) beeps.

The yellow LED also flashes this sequence.

c. Press the Alarm Silence button ⊠.

2. Check the Contrast



a. Note the initial "CONTRAST (xx)" number.

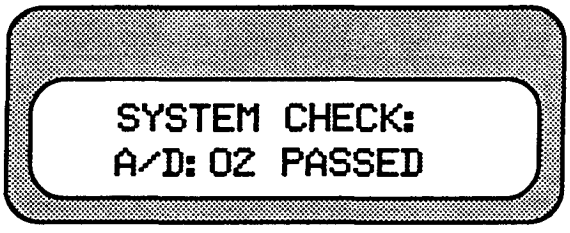
b. Turn the Inspiratory Flow knob. The display contrast should change.

c. Reset to the initial value "(xx)."

If no change,

- check the ribbon cable between J1 (Control Board) and J1 (Front Panel board), or
- replace the Front Panel board.

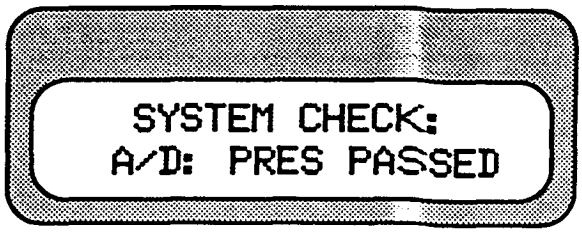
3. Check the Analog to Digital Conversion of Oxygen Output Signal



"PASSED" = correct

If "FAILED" appears, replace the Control Board.

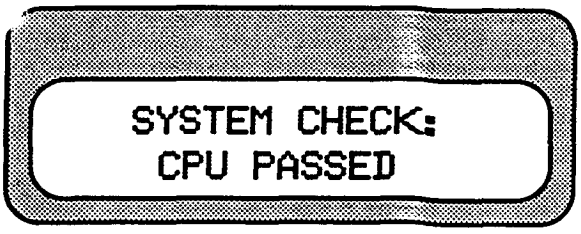
4. **Check the Analog to Digital Conversion of the Pressure Output Signal.**



"PASSED" = correct

If "FAILED" appears, replace the Control Board.

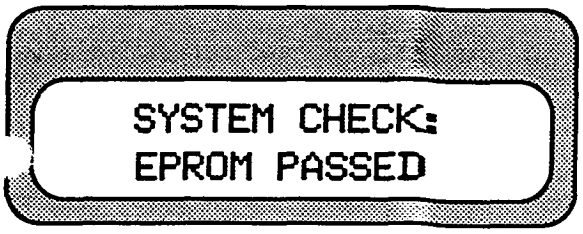
5. **Check the CPU.**



"PASSED" = correct

If "FAILED" appears, replace the Control Board.

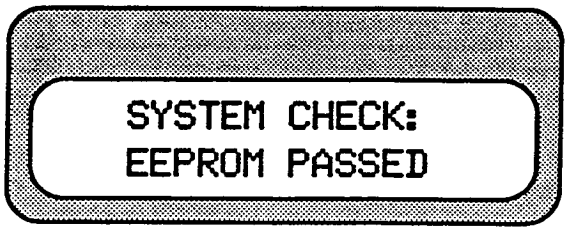
6. **Check the EPROM.**



"PASSED" = correct

If "FAILED" appears, replace the EPROM or Control Board.

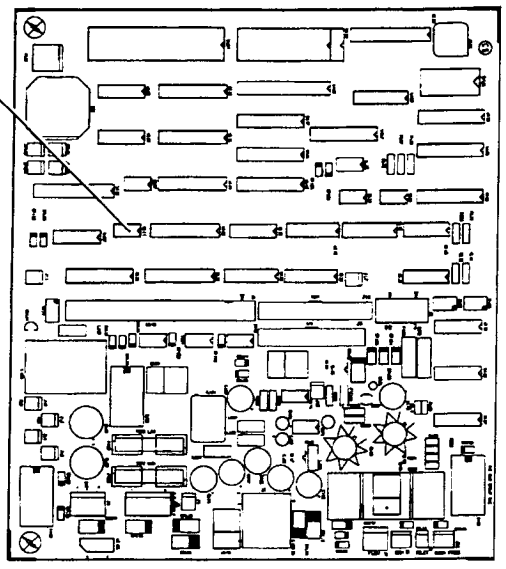
7. Check the EEPROM



"PASSED" = correct

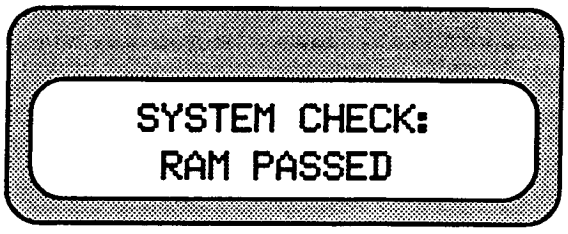
If "FAILED" appears, replace the EEPROM (U114) or the Control Board.

Important: The EEPROM and the Pneumatic Manifold Assembly must be replaced together.



AA.32.114

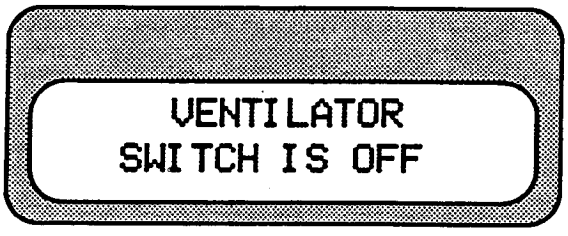
8. Check the RAM.



"PASSED" = correct

If "FAILED" appears, replace the Control Board.

9. Check the Mechanical Ventilation Switch.

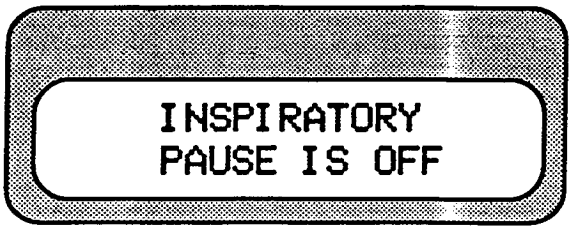


Move the Mechanical Ventilation switch ON and OFF. The screen should correspond to the switch position.

If not,

- replace the 50 pin ribbon cable or
- the Front Panel board.

10. Check the Inspiratory Pause Button

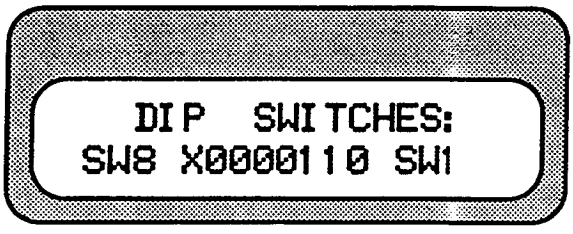


Toggle the Inspiratory Pause button between ON and OFF. The screen should read "ON" when the Green LED is ON. "OFF" when the Green LED is OFF.

If not,

- replace the switch,
- replace the 50 pin ribbon cable, or
- replace the Front Panel board.

11. Check the DIP Switches

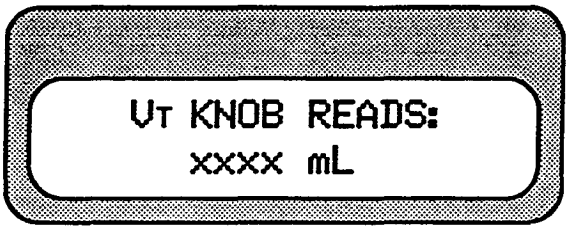


The display should match the switch bank (SW101).

Important: Do not change the position of the switches while in Service Calibration Mode.

not, replace the Control Board.

12. Check the Tidal Volume Knob



a. Rotate the Tidal Volume knob through its range.

Resolution Table

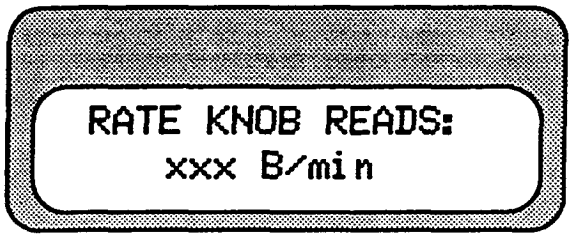
50 - 100	2 mL
100 - 250	5 mL
250 - 1000	10 mL
1000 - 1500	20 mL

b. Set the Tidal Volume to 300. The pointer and display should correspond.

If not, adjust the knob:

1. Set the Tidal Volume to display 300.
2. Loosen both set screws.
3. Position the pointer to 300 (do not rotate the shaft).
4. Tighten one set screw.
5. Set the display to 50. Does the pointer correspond?
6. Set the display to 1500. Does the pointer correspond?
7. Tighten the second set screw.

13. Check the Rate Knob



a. Rotate the Rate knob through its range.

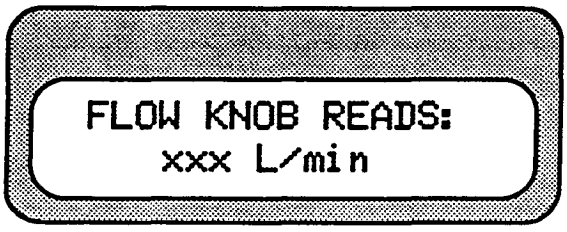
Resolution Table	
2 - 100	1 B/min

b. Set the Rate to 20. The pointer and display should correspond.

If not, adjust the knob.

1. Set the Rate to display 20.
2. Loosen both set screws.
3. Position the pointer to 20 (do not rotate the shaft).
4. Tighten one set screw.
5. Set the display to 2. Does the pointer correspond?
6. Set the display to 100. Does the pointer correspond?
7. Tighten the second set screw.

14. Check the Inspiratory Flow Knob



a. Rotate the Inspiratory Flow knob through its range.

Resolution Table

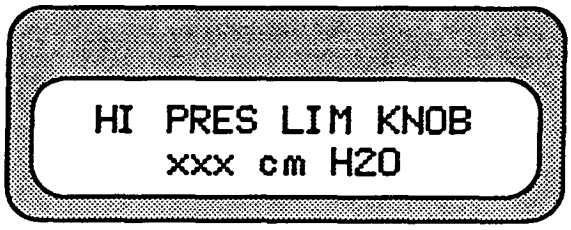
10 - 100	1 L/min

b. Set the Inspiratory Flow to 10. The pointer and display should correspond.

If not, adjust the knob.

1. Set the Inspiratory Flow to display 10.
2. Loosen both set screws.
3. Position the pointer to 10 (do not rotate the shaft).
4. Tighten one set screw.
5. Set the display to 100. Does the pointer correspond?
6. Tighten the second set screw.

15. Check the Inspiratory High Pressure Limit Knob



Note: To set the Inspiratory Pressure Limit, press in on the knob and turn.

a. Rotate the Inspiratory Pressure Limit knob through its range. When you push and turn, the knob should move smoothly. Confirm that the displayed value does not change if you do not push in.

Resolution Table

20 - 100	1 cm H_2O

b. Set the limit to 60. The pointer and display should correspond.

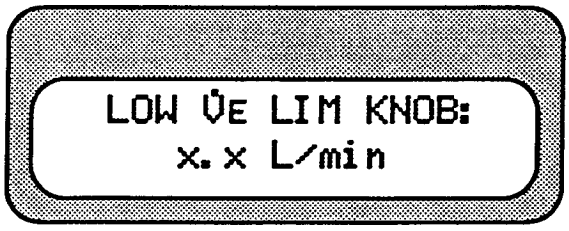
If not, adjust the knob.

1. Set the Inspiratory Pressure Limit to display 60.
2. Loosen both set screws.
3. Position the pointer to 60 (do not rotate the shaft).
4. Tighten one set screw.
5. Set the display to 20. Does the pointer correspond?
6. Set the display to 100. Does the pointer correspond?
7. Tighten the second set screw.
8. Confirm that the knob rotates freely and does not stick:
   - the setting should change when you push and turn,
   - the setting should not change when you do not push.
9. If the knob sticks, do the adjustment again.

Pushwheel Checks

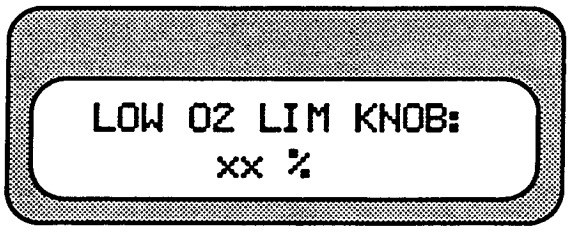
The next three checks are for the pushwheel limit switches Low $\dot{V}_E$, Low O_2 and High O_2. Step the pushwheels through their least significant and most significant digits. The display should match the setting on the pushwheel. All pushwheels should move evenly in both directions. If not, replace the Front Panel board.

16. Check the Low Minute Volume Limit Pushwheels



- Step the Low $\dot{V}_E$ tenths digit.
- Step the Low $\dot{V}_E$ ones digit.

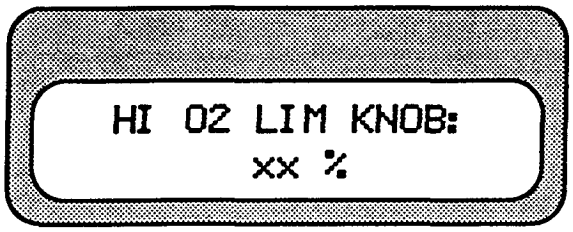
17. Check the Low Oxygen Limit Pushwheels



Note: 18% is the minimum % shown.

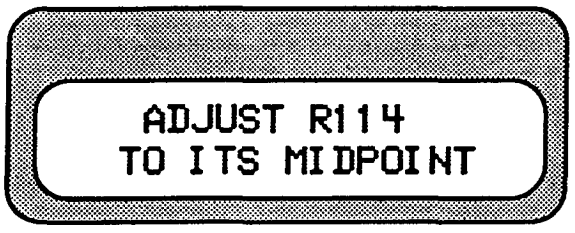
- Step the Low O_2 ones digit.
- Step the Low O_2 tens digit.

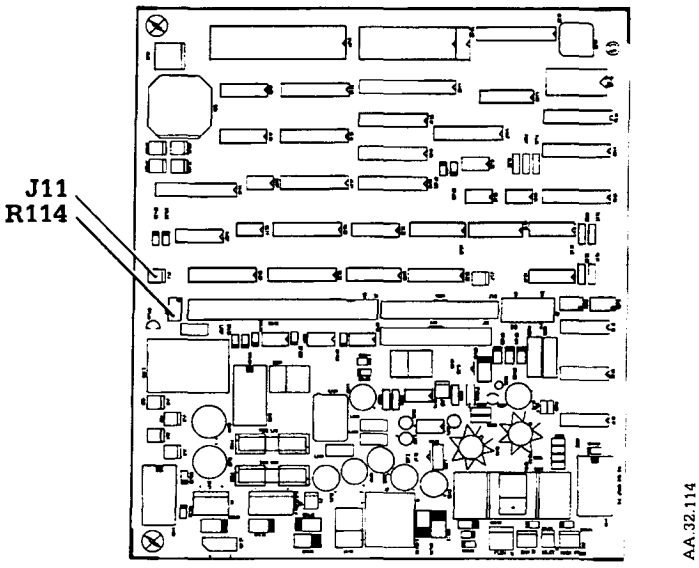
18. Check the High Oxygen Limit Pushwheels



- Step the High O_2 ones digit.
- Step the High O_2 tens digit.

19. Check the Back-Light





The back-light should be visible.

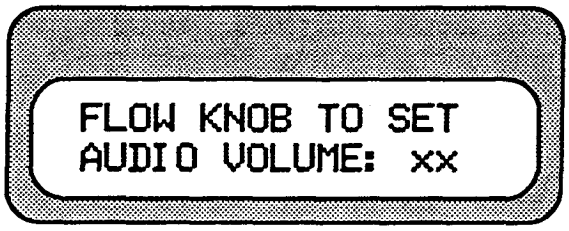
If not present adjust the intensity:

1. Turn R114 fully counterclockwise (20 turn pot). You will hear and feel a clicking sound.
2. Turn R114 ten (10) turns clockwise. This is the midpoint. The display back-light should be visible in normal light.

If not adjustable, or there is no light, the probable cause is:

- a missing jumper J11 (Control Board), the ribbon cable between J1 (Control Board) and J1 (Front Panel board), the Front Panel board, or the Control Board.

20. Check the Audio Volume



a. Note the initial "VOLUME: (xx)."

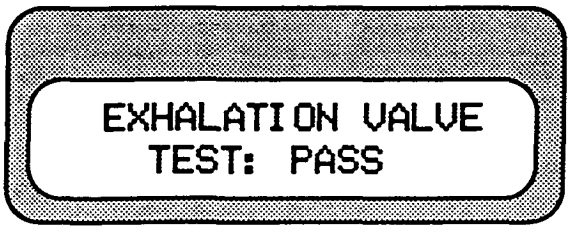
b. Turn the Inspiratory Flow knob. The volume should change.

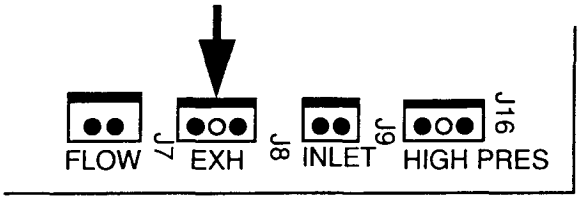
c. Reset to the initial value "(xx)."

If the Volume does not change:

- be sure the speaker is plugged into J8 (Front Panel board),
- check the ribbon cable between J1 (Control Board) and J1 (Front Panel board),
- replace the speaker, or
- replace the Front Panel board.

21. Check the Exhalation Solenoid





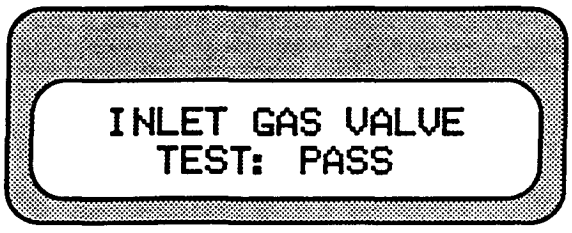
AA.32.144

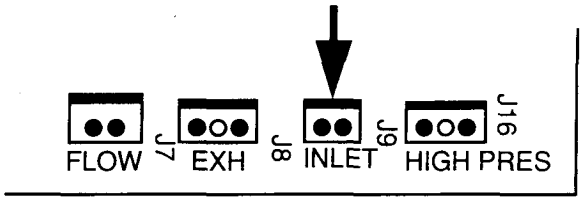
"PASS" = correct.

If "FAIL" appears:

- follow the cable connections from J8 (Control Board) through the Header board, to the solenoid,
- replace the Exhalation Solenoid (SOL2), or
- replace the Control Board.

22. Check the Inlet Solenoid





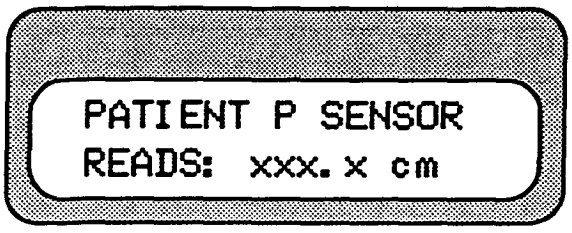
AA.32.145

"PASS" = correct.

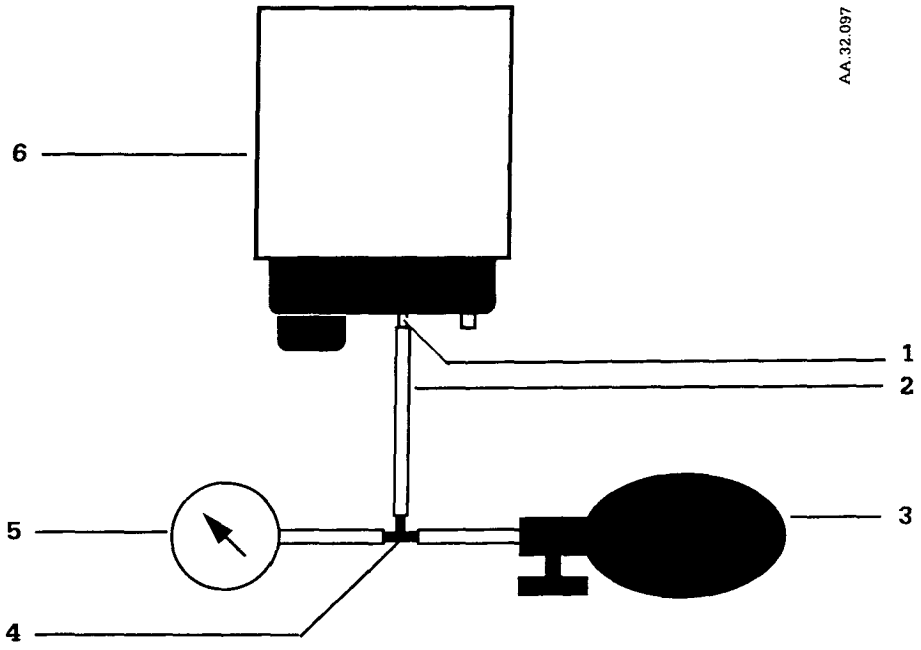
"FAIL" appears:

- follow the cable connections from J9 (Control Board) through the Header board, to the solenoid,
- replace the Inlet Solenoid (SOL1), or
- replace the Control Board.

23. Check the Patient Pressure Sensor Calibration



Connect the test equipment to the Ventilator.



1. Patient Pressure Sensing Input
2. Tubing
3. Squeeze Bulb with Valve
4. Tee
5. Pressure Gauge
6. Control Module, top view

Figure 4-2 Patient Pressure Sensor Calibration

a. Adjust R102 (zero) on the Pressure Transducer board until the Display also reads zero (0) ± 0.5 cm H_2O. The adjustment resistor can be accessed through the black rubber seal in the inner pneumatic enclosure.

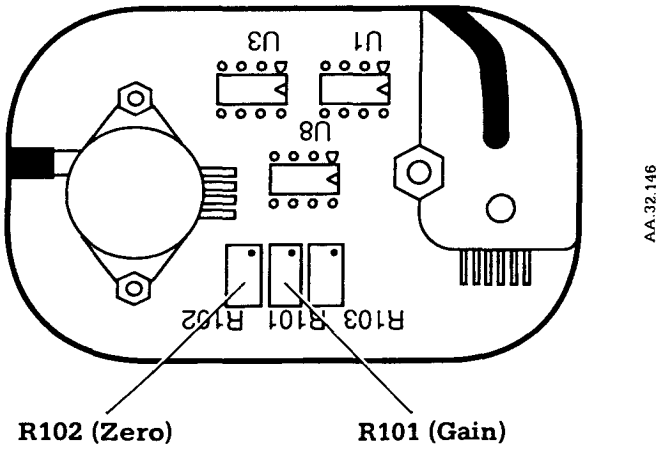


Figure 4-3 Patient Pressure Sensor, Zero and Gain Calibration

b. Lightly squeeze the hand bulb to bring the pressure to 100 ± 1 cm H_2O on the gauge.

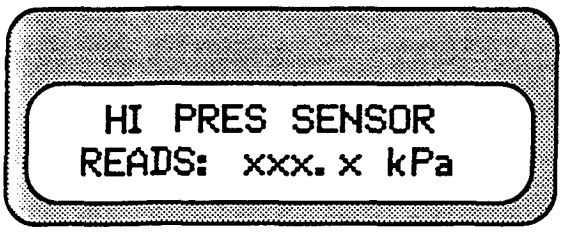
c. The display should read 100 ± 1 cm H_2O. If not, adjust R101 (gain) on the Pressure Transducer board.

d. After adjusting the gain, release the pressure and repeat the calibration for zero (0 cm H_2O). Repeat the gain and zero adjustments until both are within specification.

e. Check the sensor linearity by lightly squeezing the bulb to bring the pressure to 50 ± 1 cm H_2O on the gauge. The display should be 50 ± 2 cm H_2O.

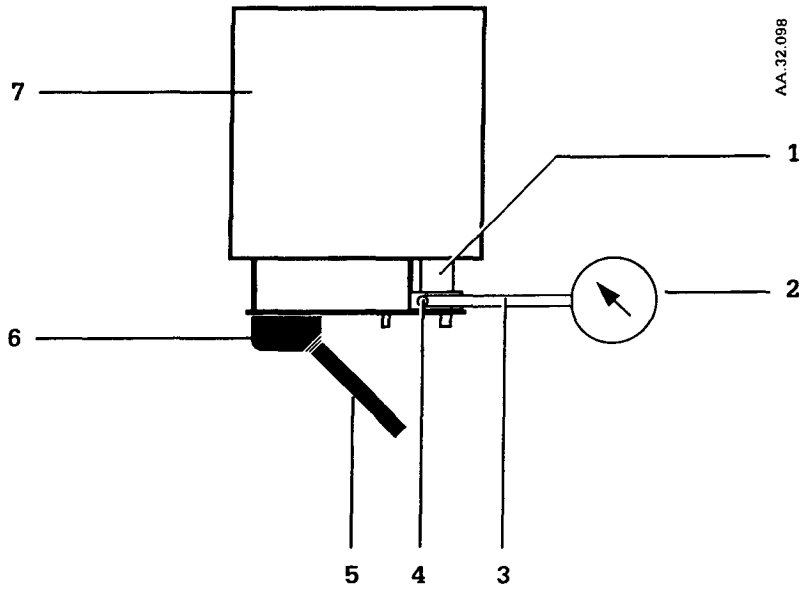
If the zero, gain, or linearity specifications can not be met, replace the Pressure Transducer board.

24. Check the High Pressure Sensor Calibration



a. Disconnect the Gas Supply if present.

b. Remove the Pneumatic Cover and install a tube in the Test Port. Attach a gauge, with a range of at least 400 kPa.



1. Pneumatic Manifold Assembly
2. Pressure Gauge
3. High Pressure Tube
4. Test Port
5. Gas Supply
6. Inlet Block.
7. Control Module (top view)

Figure 4-4 High Pressure Sensor Calibration

c. Reconnect the Gas Supply (276 ± 14 kPa). You will need to attach the Inlet Block.

d. The gauge should read approximately 180 kPa. The display should read within ± 3 kPa of the gauge. To calibrate the display, adjust the high pressure offset (R103) on the Pressure Transducer board.

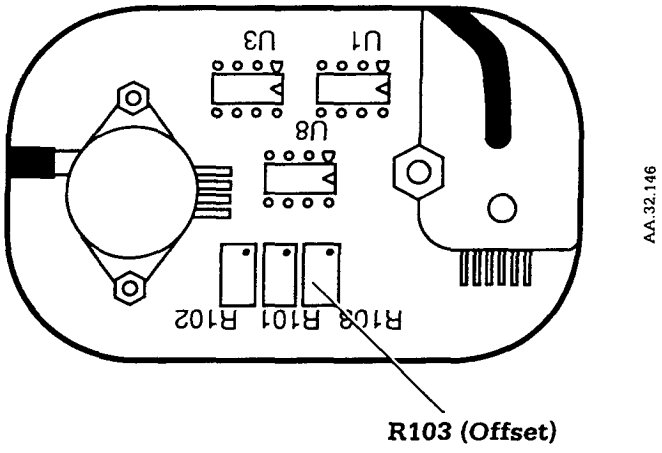
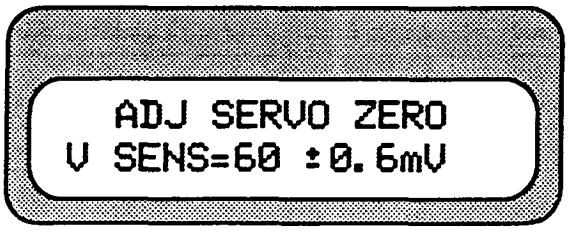


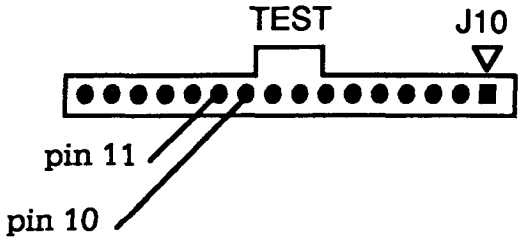
Figure 4-5 High Pressure Sensor Offset Calibration

If you can not meet the specification, replace the Pressure Transducer board.

e. Leave the gauge attached.

25. Check the Flow Control Zero Calibration





a. Move the Mechanical Ventilation switch to ON.

Note: Mechanical Ventilation ON allows you to toggle repeatedly between the Zero and Gain checks, by pressing the Alarm Silence button ⊠. If you adjust the Zero or the Gain, you must check the other adjustment. Do not proceed until both are within specification.

b. Measure across J10, pin 11 to pin 10, on the Control Board. The meter reading should be 60.0 ± 0.6 mV dc.

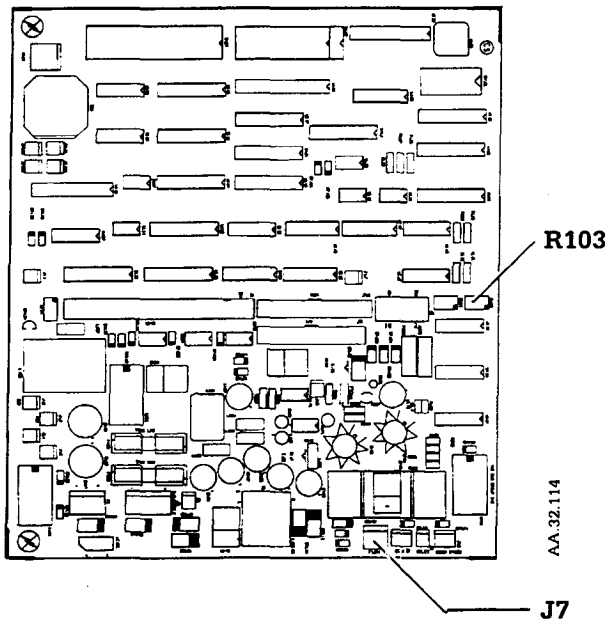
If not,

- adjust R103 (zero, Control Board).

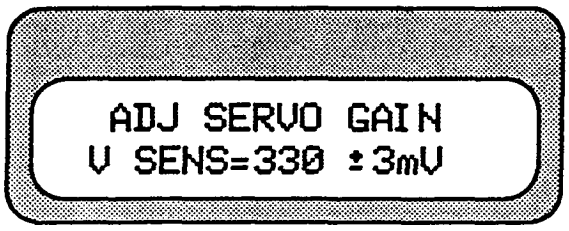
If you can not adjust,

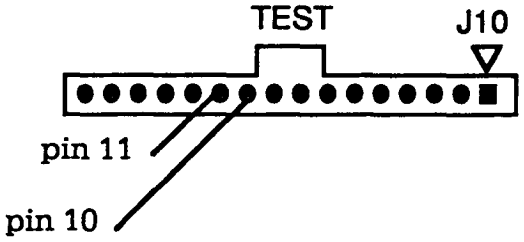
- check the J7 Flow Valve connection, or
- replace the Control Board.

c. Press the Alarm Silence button ⊠ to toggle to Gain calibration.



26. Check the Flow Control Gain Calibration





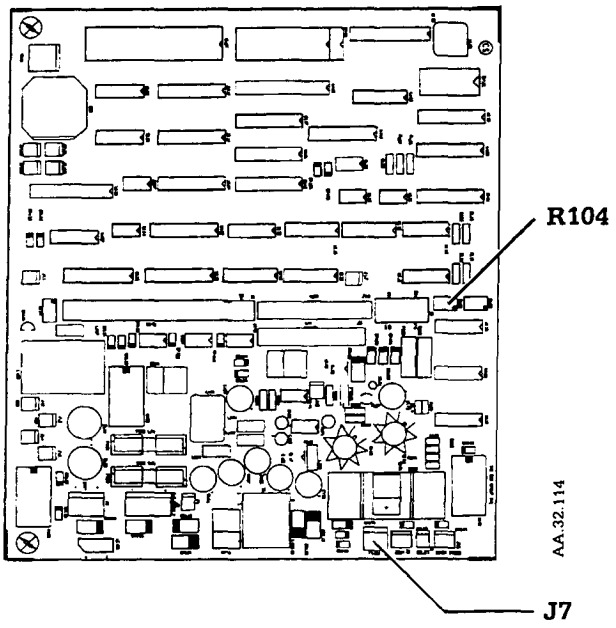
a. Measure across J10, pin11 to pin10, on the Control Board. The meter reading should be 330 ± 3 mV dc.

If not,

- adjust R104 (gain, Control Board).

If you can not adjust,

- check the J7 Flow Valve connection, or
- replace the Control Board.

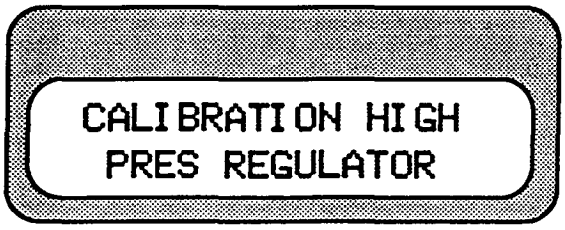


b. If R104 was adjusted, press the Alarm Silence button ⊠ to check the Zero calibration (60.0 ± 0.6 mV dc).

c. The adjustments of pots R103 and R104 are interrelated. If either is adjusted the other will have to be checked. Press the Alarm Silence button to go to the other check.

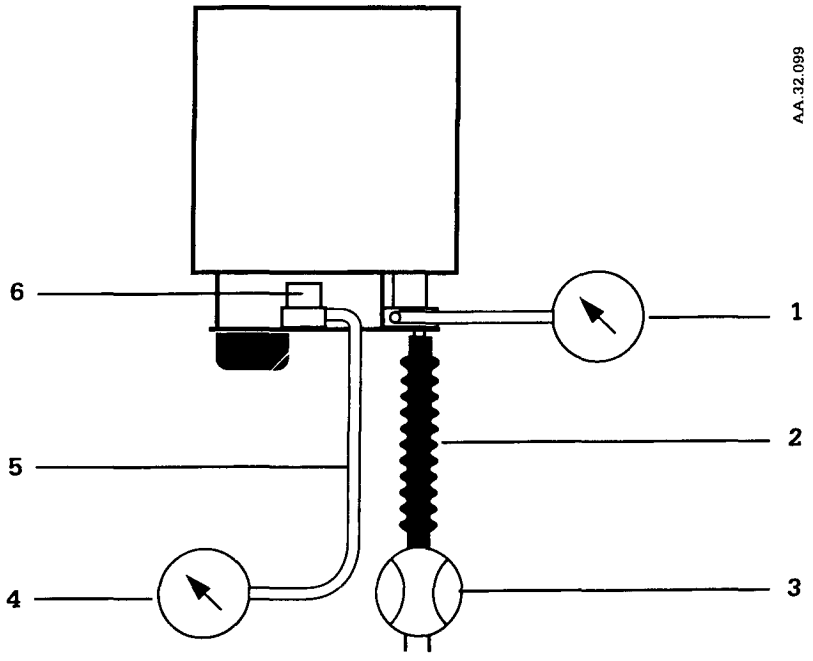
d. When the Zero and Gain adjustments are both within specification, move the Mechanical Ventilation switch to OFF.

27. Regulator Calibration Setup



Preparation:

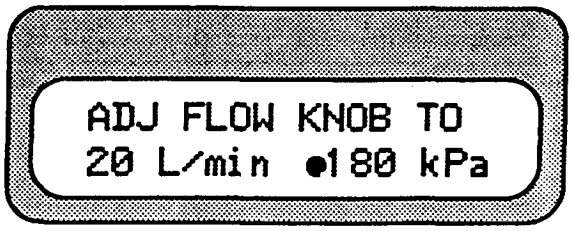
- Attach a flowmeter to the Drive Gas outlet.
- Disconnect the output tube (TA-11) from the output of the Secondary Regulator. Attach a pressure gauge capable of measuring 150 cm H_2O.
- The pressure gauge (400 kPa), should still be attached to the Test Port.



1. Pressure Gauge
2. 17mm Hose
3. Flowmeter
4. Pressure Gauge
5. Tubing
6. Secondary Regulator

Figure 4-6 Regulator Calibration Setup

28. Check the Regulator Pressures



Check the Primary Regulator pressure gauge (180 ± 3 kPa). The Primary Regulator must be working before the Secondary Regulator can be checked.

Check the Secondary Regulator Calibration

a. The output pressure should be 125 ± 5 cm H_2O.
   If not, adjust the Secondary Regulator.

b. Remove the gauge from the Secondary Regulator and attach the tube.

Check the Primary Regulator Calibration

a. Move the Mechanical Ventilation switch to ON.

b. Adjust the Inspiratory Flow knob to acquire 20.0 ± 0.5 L/min output.

c. Check the Primary Regulator pressure. Is it 180 ± 2 kPa?
If not, adjust the Primary Regulator while maintaining 20 L/min flow.

If you can not adjust to 180 ± 2 kPa while maintaining 20 L/min flow, replace the Primary Regulator.

Note: If you adjust the Primary Regulator you must check the Secondary Regulator calibration again.

d. Adjust the Inspiratory Flow knob to acquire 10.0 ± 0.5 L/min output.

e. Check the pressure. Is it 180 ± 7 kPa?
If not, replace the Primary Regulator.

f. Adjust the Inspiratory Flow knob to acquire 100 ± 5 L/min output.

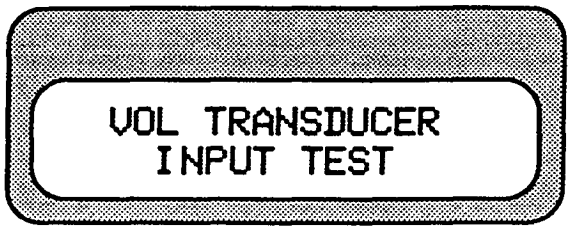
g. Check the pressure. Is it 180 +0/ -14 kPa?
If not, replace the Primary Regulator.

h. Move the Mechanical Ventilation switch to OFF.

i. Disconnect the Gas Supply.

j. Remove all test equipment. Install the Test Port plug.

29. Volume Transducer Input Setup



- Connect the volume transducer to the system Common Gas Outlet. Arrows in the direction of flow.
- Set the Anesthesia System flow to 8 L/min.

30. Check the Flow Detection

a. The display should read "8.0 L/min FWD->" ± 2 L/min.

b. Reverse the sensor clip direction. The arrows against the direction of flow.

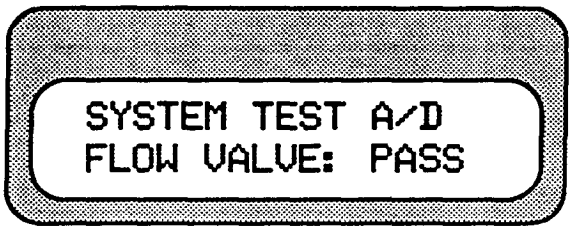
c. The display should now read "8.0 L/min <-REV" ± 2 L/min.

If either flow detection doesn't work:

- check the sensor,
- check the Sensor Interface panel connections,
- check the Excel interface cable,
- check the EMC/Interface board,
- check the 50 pin ribbon cable between J1 (Front Panel board) and J1 (Control Board).

d. Return the sensor assembly to the breathing circuit.

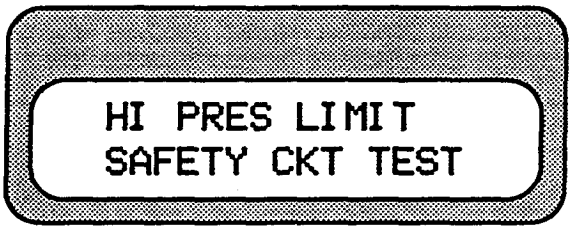
31. Check the Analog to Digital Conversion of Flow Valve Drive



"PASS" = correct.

If "FAIL" appears, replace the Control Board.

32. High Pressure Limit Setup



Connect an adjustable pressure source (135 ± 5 cm H_2O) to the Ventilator Drive Gas outlet.

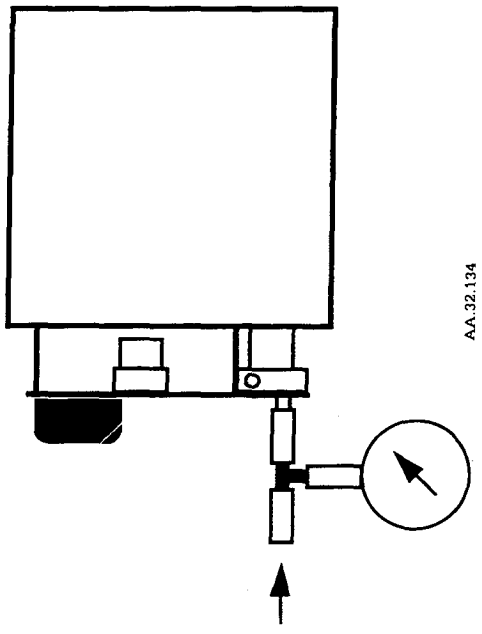
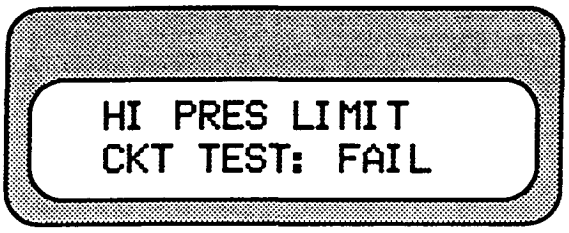


Figure 4-7 High Pressure Limit Setup

33. Check the High Pressure Limit



"FAIL" is displayed upon entering this check.

a. Raise the pressure slowly and check that the pressure drops sharply between 105 and 115 cm H_2O. The display should read "PASS" after the pressure drops.

Note: The Flow Control Valve may have a small leak (within specification). If Supply Gas is connected and the Drive Gas outlet is blocked, this leakage can cause the pressure to slowly increase.

If the pressure does not drop:

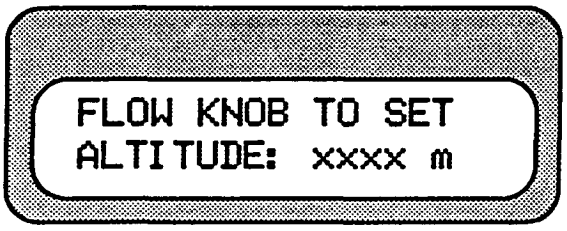
- check the connections between J16 (Control Board), through the Header board, to the High Pressure Limit switch,
- check the tubing, or
- replace the High Pressure Safety switch.

To repeat this check, move the Mechanical Ventilation switch to ON and press the Alarm Silence button ⊠ twice.

To exit, the Mechanical Ventilation switch must be OFF.

b. Remove the test equipment.

34. Check the Altitude Setting

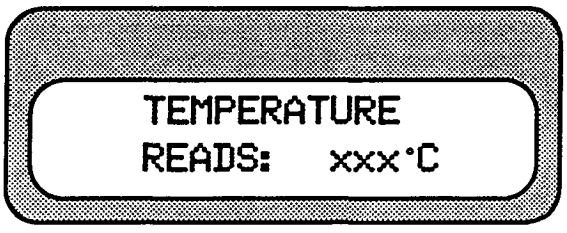


a. Turn the Inspiratory Flow knob. The altitude should change from 0 to 3000 in increments of 100 meters.

b. Enter the correct altitude (1 foot = 0.3048 meters). Advise the hospital personnel if this selection is different than the original.

⚠WARNING: If the altitude setting is wrong, false pressure readings can potentially cause the Ventilator to operate out of calibration.

35. Check the Temperature Sensor



The display should indicate 25 °C.

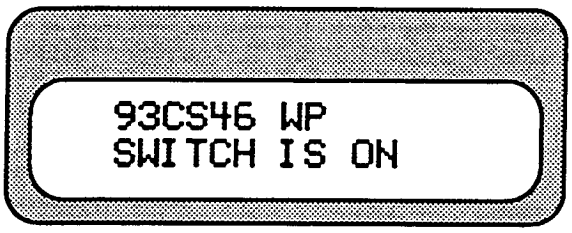
If not, replace the Pressure Transducer board.

Insure DIP SW101, switch 4 is still OFF.

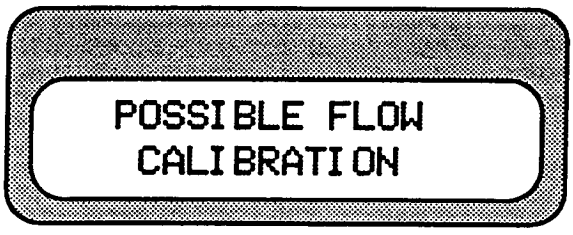
⚠CAUTION: If switch 4 is left ON and you move to the next check, the EEPROM may get corrupted.

36. Flow Calibration Status

If DIP SW101, switch 4 is OFF (the correct setting), this step is bypassed. If DIP SW101 switch 4 is ON one of the following displays will appear.



If the message "93CS46 WP SWITCH IS ON" appears, the EEPROM is properly write protected. Press the Alarm Silence button ⊠ to enter the next check.

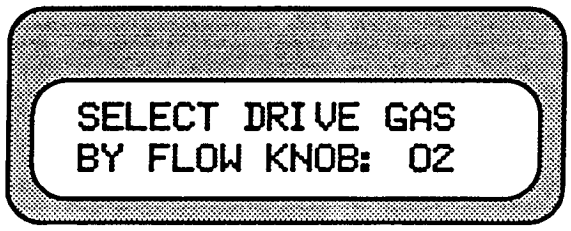


If the message "POSSIBLE FLOW CALIBRATION" appears, and you advance to the next step without moving switch 4 to OFF, the EEPROM will be damaged. Replacement of the EEPROM and Pneumatic Manifold Assembly will then be required.

⚠CAUTION: If switch 4 is left ON and you move to the next check the EEPROM will be corrupted.

Insure DIP SW101, switch 4 is OFF. You can now press the Alarm Silence button ⊠ to enter the next check.

37. Check the Drive Gas Selection



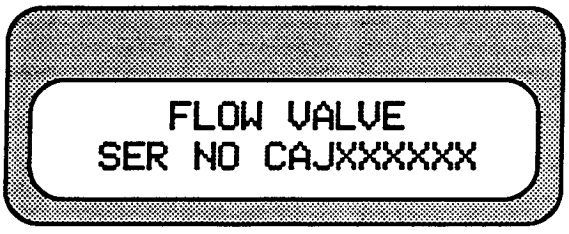
Note the setting. This must correspond to the existing Gas Supply fitting.

If the Drive Gas selection must be changed, rotate the Inspiratory Flow knob to select the correct Drive Gas. Advise hospital personnel if you change the setting.

If "ERR" appears, and cannot be changed to "O2" or "Air," replace the EEPROM and Pneumatic Manifold Assembly.

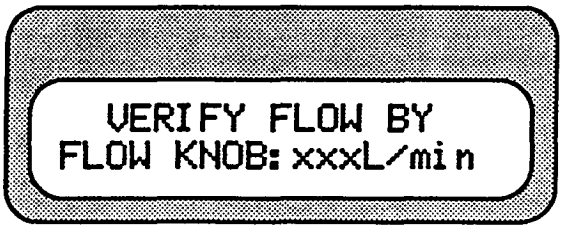
⚠WARNING: When the gas selection is changed, further changes must be made to the Ventilator Gas Supply connections.

38. Check the Flow Control Valve Serial Number



The displayed serial number must match the number on the Flow Control Valve. If not, the EEPROM and Pneumatic Manifold Assembly will have to be replaced.

39. Check the Flow



a. Connect Gas Supply (276 ± 14 kPa).

b. Connect a flowmeter to the Drive Gas outlet.

c. Move the Mechanical Ventilation switch to ON.

d. Adjust the Inspiratory Flow as per the table.

Important: The accuracy limits of the measuring device shall not be greater than ± 3%. The total flow specification for the ventilator, and measuring device, is ± 10%.

* The minimum and maximum respirometer readings, in the table, have been adjusted to compensate for the response characteristics, and ± 3% accuracy, of type RM121, and RM211 respirometers.

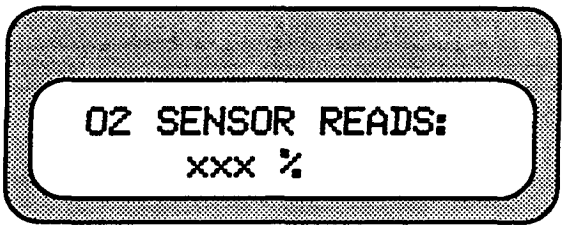
Inspiratory Flow Setting	Flow Specification (liters per minute)	* Respirometer Readings after 60 Seconds (liters)	
		Minimum	Maximum
10	10 ± 10%	8.6	9.9
16	16 ± 10%	14.8	17.0
30	30 ± 10%	29.6	34.0
45	45 ± 10%	45.4	52.2
60	60 ± 10%	60.6	69.7
80	80 ± 10%	80.3	92.4

If the Flow does not meet specification:

- Assure the supply pressure stays at 276 ± 14 kPa for each flow setting,
- check the Primary Regulator pressure,
- check the Secondary Regulator pressure,
- make sure the Exhalation Valve is not open; High Pressure Limit Switch pressure was met,
- check for blockage in the Pneumatic Manifold Assembly, or
- replace the EEPROM and Pneumatic Manifold Assembly.

e. Move the Mechanical Ventilation switch to OFF.

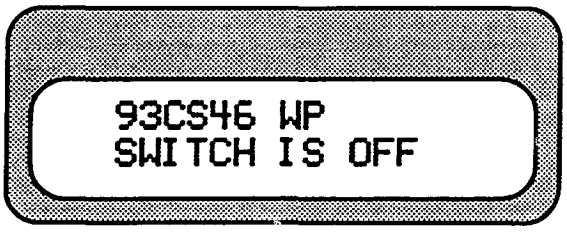
40. Check the O_2 Sensor



Calibrate the oxygen sensor as specified in the Operation and Maintenance manual.

41. EEPROM Write Protect Status

When the EEPROM is functioning correctly, this step is bypassed.



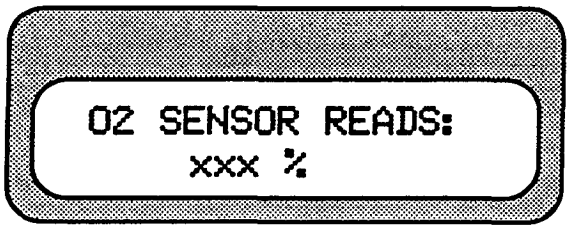
If the message "93CS46 WP SWITCH IS OFF" appears, the EEPROM is damaged. Replace the EEPROM and Pneumatic Manifold Assembly.

If the Flow does not meet specification:

- Assure the supply pressure stays at 276 ± 14 kPa for each flow setting,
- check the Primary Regulator pressure,
- check the Secondary Regulator pressure,
- make sure the Exhalation Valve is not open; High Pressure Limit Switch pressure was met,
- check for blockage in the Pneumatic Manifold Assembly, or
- replace the EEPROM and Pneumatic Manifold Assembly.

e. Move the Mechanical Ventilation switch to OFF.

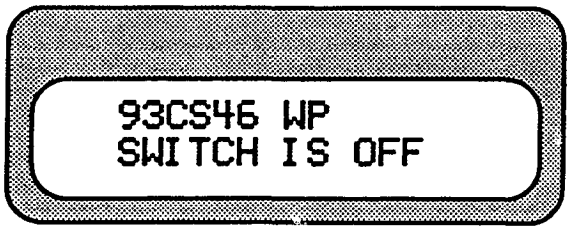
40. Check the O_2 Sensor



Calibrate the oxygen sensor as specified in the Operation and Maintenance manual.

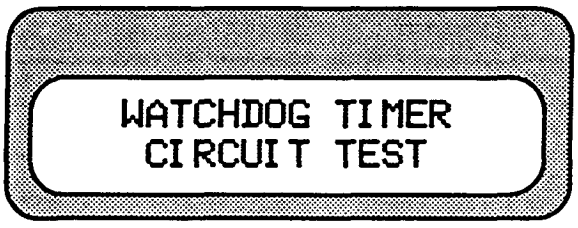
41. EEPROM Write Protect Status

When the EEPROM is functioning correctly, this step is bypassed.



If the message "93CS46 WP SWITCH IS OFF" appears, the EEPROM is damaged. Replace the EEPROM and Pneumatic Manifold Assembly.

42. Check the Watchdog Timer



a. Press the Alarm Silence button ⊠.

- You will hear a short (1kHz) beep,
- followed by long repeating (1kHz) beeps.
- Within 25 seconds, you should hear long (3kHz) beeps coming from the buzzer (BZ1) on the Control Board.

The yellow LED flashes the same sequence.

If not, replace the Control Board.

b. Set the DIP switches to operational mode (1 ON, 2, 3, 4 OFF).

⚠WARNING: Failure to return ALL DIP Switches to their proper positions will cause the Ventilator to malfunction and injury to the patient could occur.

D. Touch Sense Test

1. Set the touch to read controls as follows:
   - Tidal Volume 300 mL
   - Rate 20 B/min
   - Inspiratory Flow 100 L/min
2. Move the Mechanical Ventilation switch to ON.
3. Touch each of the knobs. The display should indicated the knob that is touched. No touch-to-read message should appear unless the knob is touched.

If not: adjust the sensitivity.

The adjustment resistors are on the back side of the Front Panel board (Solder Side). From the front of the Control Module, the adjustments go from left to right (R83, R82, R81) corresponding to the location of the knobs.

Knob	Test Point	Adjustment
Tidal Volume	J10, pin 2	R83
Rate	J10, pin 3	R82
Inspiratory Flow	J10, pin 4	R81

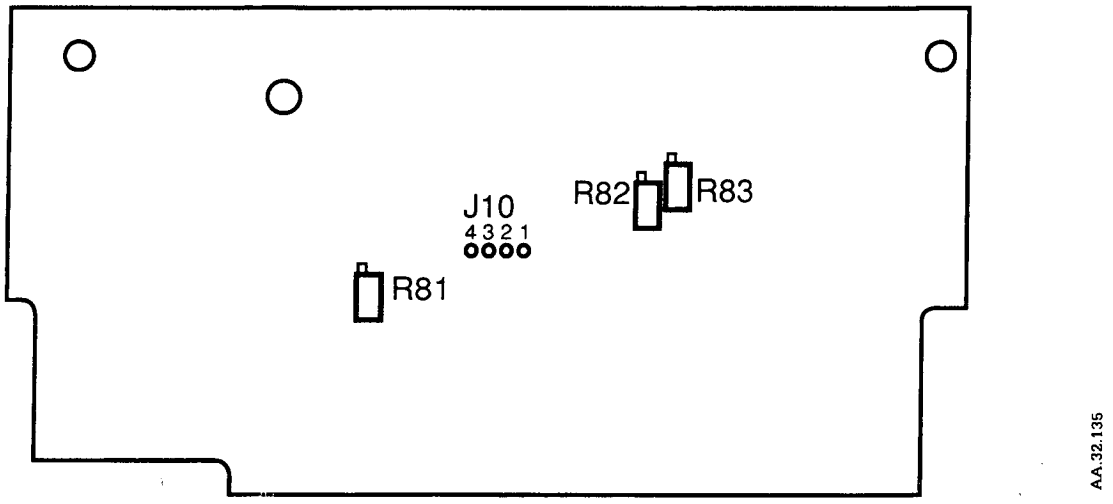


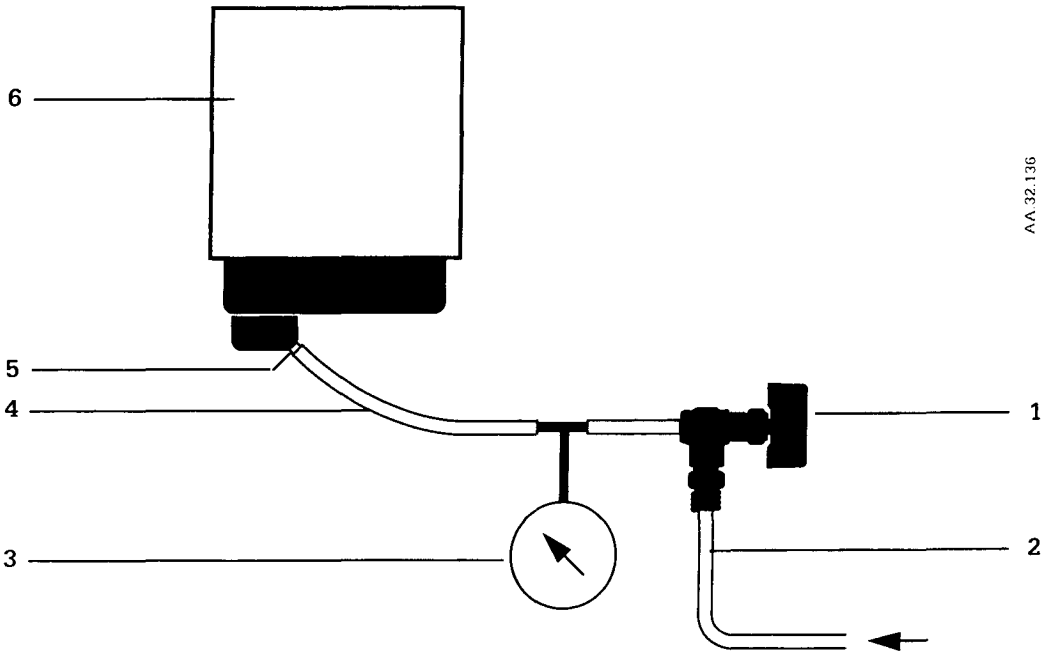
Figure 4-8 Front Panel board, Back Side

1. Adjust for 0 V dc with respect to J10, pin 1 (AGND) on the Front Panel board.
2. Adjust the resistor an additional 7 turns counterclockwise after adjusting for 0 V dc.
3. Repeat the test.

E. Leak Test

Tools Required:

- Pressure Gauge, 400 kPa (accurate to 5 kPa)
- Shut off valve
- Stopwatch, not shown
- Gas Supply hose
- Supply fitting (see section "8/Illustrated Parts")



1. Shut Off Valve
2. Gas Supply
3. Pressure Gauge
4. Supply Gas Hose
5. Supply Gas Fitting
6. Control Module, top view

Figure 4-9 Leak Test.

1. Connect Supply Gas to the Control Module as shown in the illustration.
2. Pressurize the Control Module to 345 kPa.
3. Close the shut off valve and start the Stopwatch. The pressure drop should not exceed 5 kPa in 87 seconds.

   If pressure cannot be maintained:
   - check for loose hose fittings, holes in the hoses, or
   - repair the Control Module.

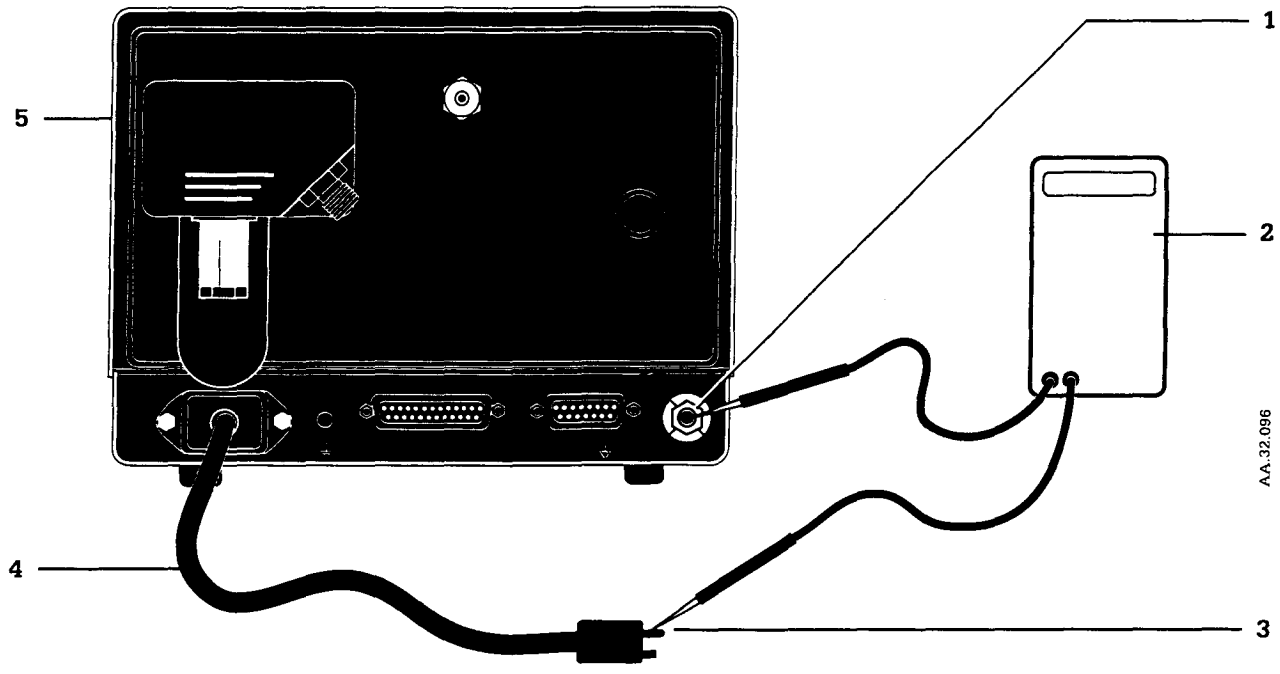
4. Disconnect the test setup.

F. Ground Impedance Test

1. Measure the resistance between the Ground termination on the line cord, and the equipotential connector. It should be less than 0.10 Ohms. The other two line cord terminations should have a high resistance with respect to the equipotential connector.

If the resistance is too high:

- check for loose or oxidized connections, or
- replace the power cord.



1. Equipotential Connector
2. Meter
3. Termination
4. Line Cord
5. Control Module

Figure 4-10 Ground Impedance Test.

G. Leakage Current Test

Tools Required:

- Leakage Current Tester

Follow the instructions included with the Leakage Current Tester. You must measure the leakage current in four wiring configurations. With the Ventilator grounded and ungrounded, and with the Line and Neutral wires normal and reversed. In all cases there must be less than 100 micro amperes of leakage current, with any Ventilator voltage selector setting.

- Ventilator ON, polarity normal, grounded.
- Ventilator ON, polarity normal, ungrounded.
- Ventilator ON, polarity reversed, grounded.
- Ventilator ON, polarity reversed, ungrounded.

End of Test and Calibration

You have now completed all of the checks and calibrations. Ensure that all previously recorded parameters have been restored.

Perform section "3/ Post-Service Checkout" now.

⚠**WARNING: You must perform section "3/ Post-Service Checkout" before returning the system to clinical use. Failure to do so could cause injury to the patient.**

5/Maintenance

5.0 Maintenance Schedule

⚠WARNING: Do not perform testing or maintenance on this instrument while it is being used to ventilate a patient, possible injury may result.

⚠WARNING: Items may be contaminated due to infectious patients. Wear sterile rubber gloves. Contamination can spread to yourself and others.

User level maintenance is found in the Operation and Maintenance manuals.

Yearly Maintenance

Inspect:

- ❑ Ventilator Tubing
- ❑ Bellows

Replace:

- ❑ Exhalation Valve Diaphragm
- ❑ Exhalation Valve Retainer 'O'-Ring
- ❑ Free Breathing Valve
- ❑ Free Breathing Valve Seat 'O'-Ring
- ❑ Inlet Valve 'O'-Rings (2)
- ❑ Inlet Valve 'U' Cup Seals (2)
- ❑ 5 micron Filter (Secondary Regulator)
- ❑ 5 micron Filter (Gas Inlet, if present))

Test:

- ❑ Perform section 4/Tests and Calibration
- ❑ Perform section 3/Post-Service Checkout

Two Year Maintenance

Replace:

- ❑ Internal Battery

Test:

- ❑ Perform section 4/Tests and Calibration
- ❑ Perform section 3/Post-Service Checkout

5/Maintenance

5.1 Maintenance Procedures

In order to perform maintenance, you must remove the Inlet block, the Pneumatic Cover and the entire Pneumatic Mounting Plate assembly.

Exhalation Valve Maintenance

1. Remove the retaining ring and lift the assembly out of the manifold. **Important:** Do not loosen the elbow fitting.
2. Replace the diaphragm on the retainer.
3. Replace the O-Ring. Lubricate with a thin film of KRYTOX™ (oxygen-use-approved) lubricant.
4. Insert the assembly into the manifold.
5. Install the retaining ring flat side up (away from the manifold).

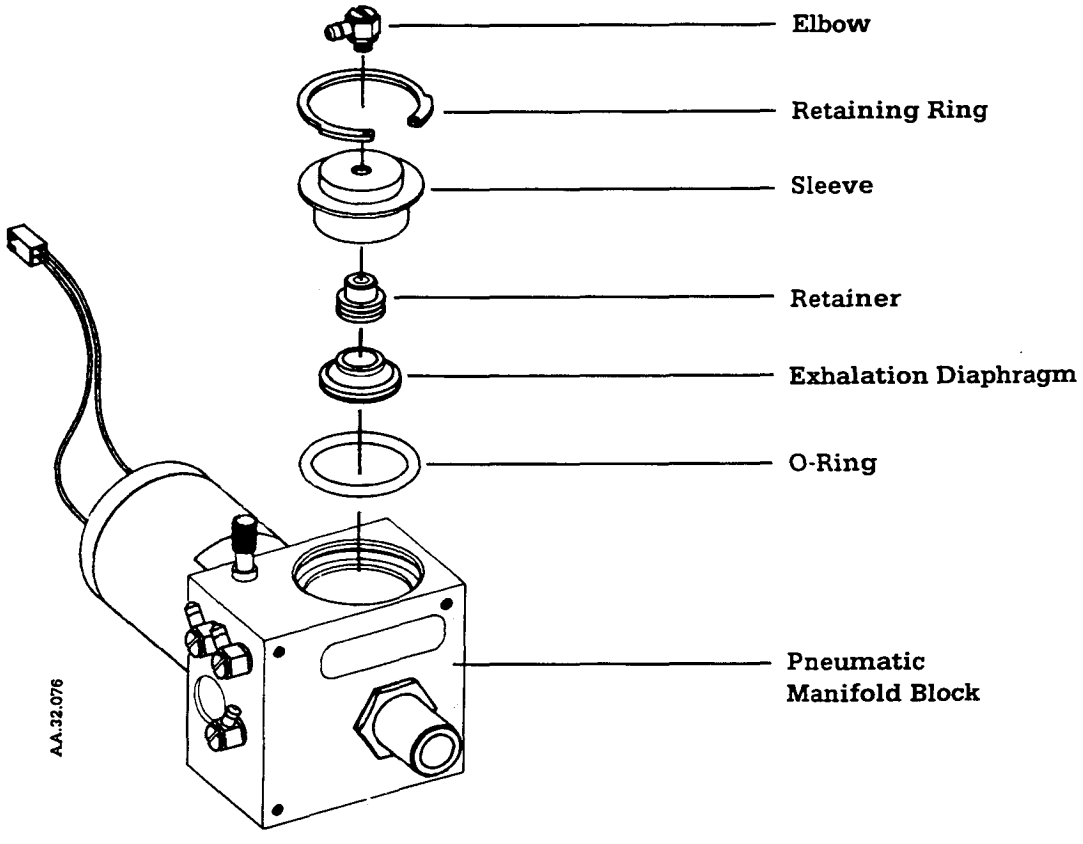


Figure 5-1 Exhalation Valve Maintenance

Free Breathing Valve Maintenance

6. Unscrew the Valve Seat.
7. Pull the Free Breathing Valve out.
8. Inspect the Valve Seat for cleanliness.
9. Pull the tail of the new Free Breathing Valve through the center of the Valve Seat until it locks in place.
10. Trim the tail in line with the bottom edge of the Valve Seat.
11. Replace the O-Ring. Lubricate with a thin film of KRYTOX™.
12. Screw the assembly into the manifold.

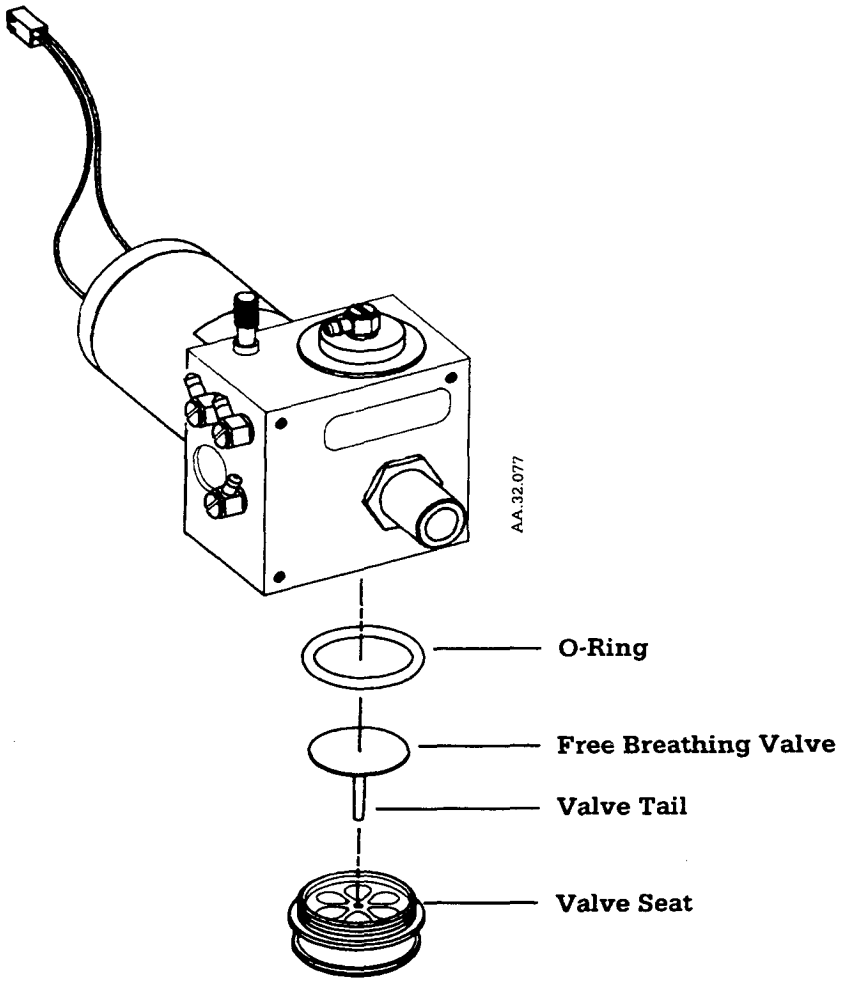


Figure 5-2 Free Breathing Valve Maintenance

Gas Inlet Valve Maintenance

13. Remove the retaining ring and cap.
14. Remove the Shuttle and replace the first U-cup seal. Lubricate the seal with KRYTOX™.
15. Replace the Second O-ring and Second U-cup seal. Lubricate the O-ring and seal with KRYTOX™.
16. Install the Shuttle.
17. Replace and lubricate the First O-ring as you install the Inlet Valve cap.
18. Install the retaining ring flat side out (away from the block).

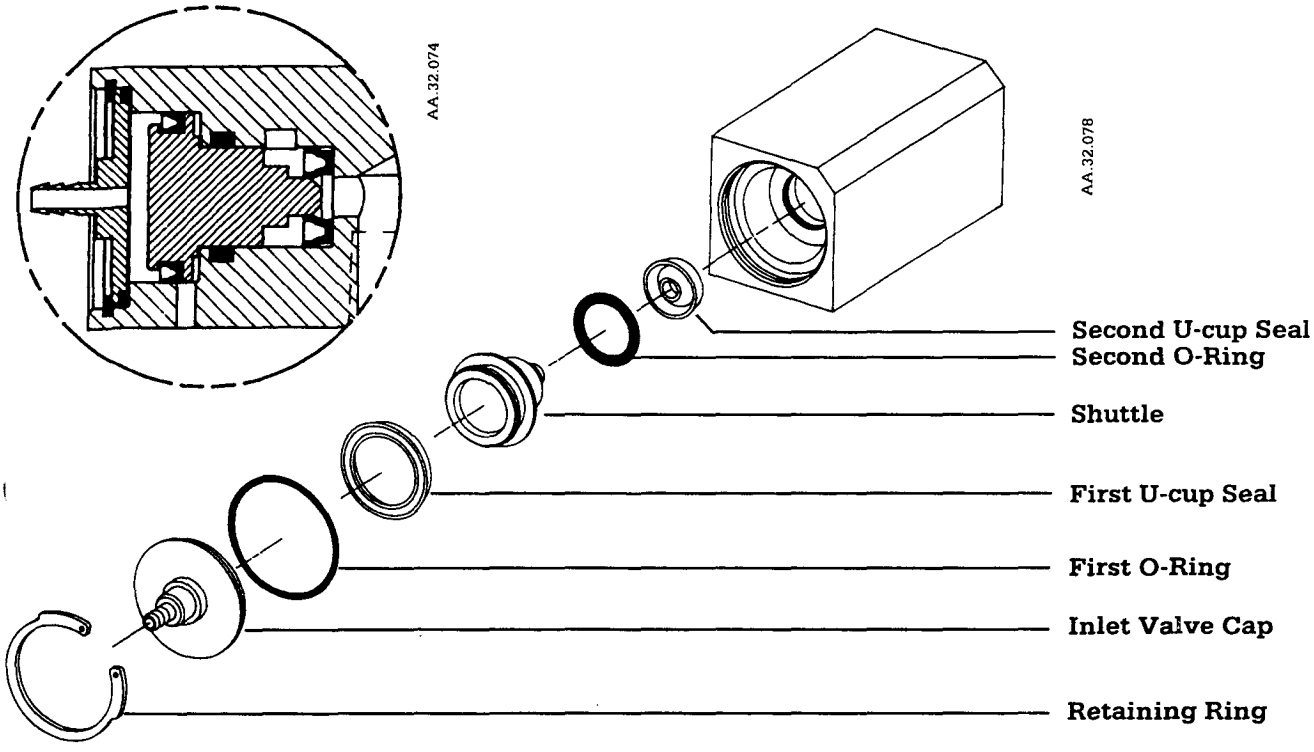


Figure 5-3 Gas Inlet Valve

Secondary Regulator Filter Replacement

19. Replace the filter assembly (TA1, Filter, TA2).

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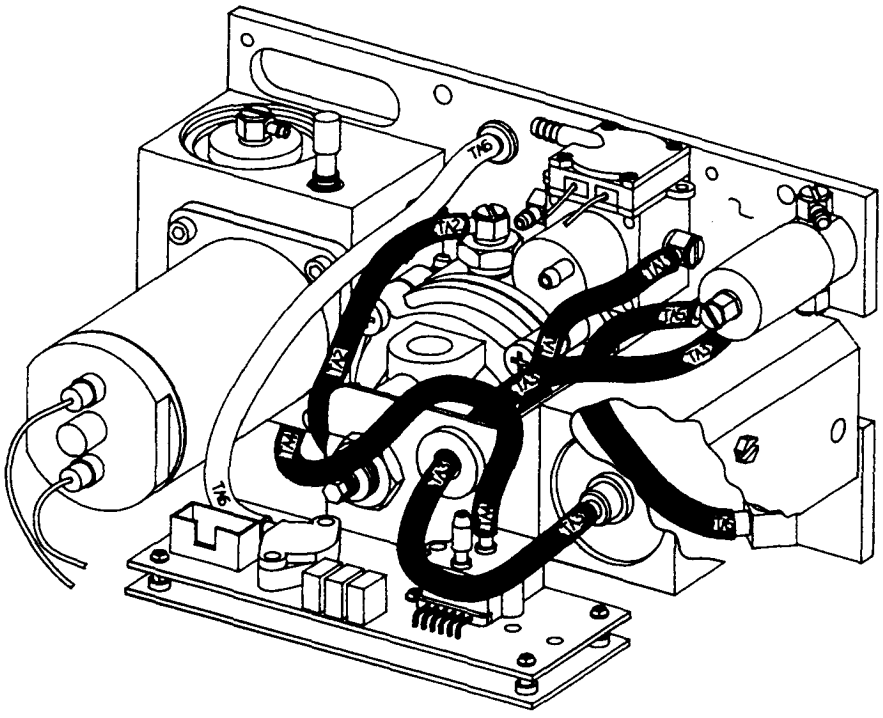

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Figure 5-4 Secondary Regulator Filter

20. Connect the Header board cables.
    - J1 (Control Board) Red, Black
    - J2 (Control Board) multi-color

21. Attach the Pneumatic Mounting Plate assembly, the Pneumatic Cover and the Inlet Block.

Gas Inlet Filter Maintenance

22. Replace the filter as per section "6/Maintaining the Ventilator" found in the Operation and Maintenance manual.

Battery Replacement

23. Replace the battery every two years, J2 (Control Board).

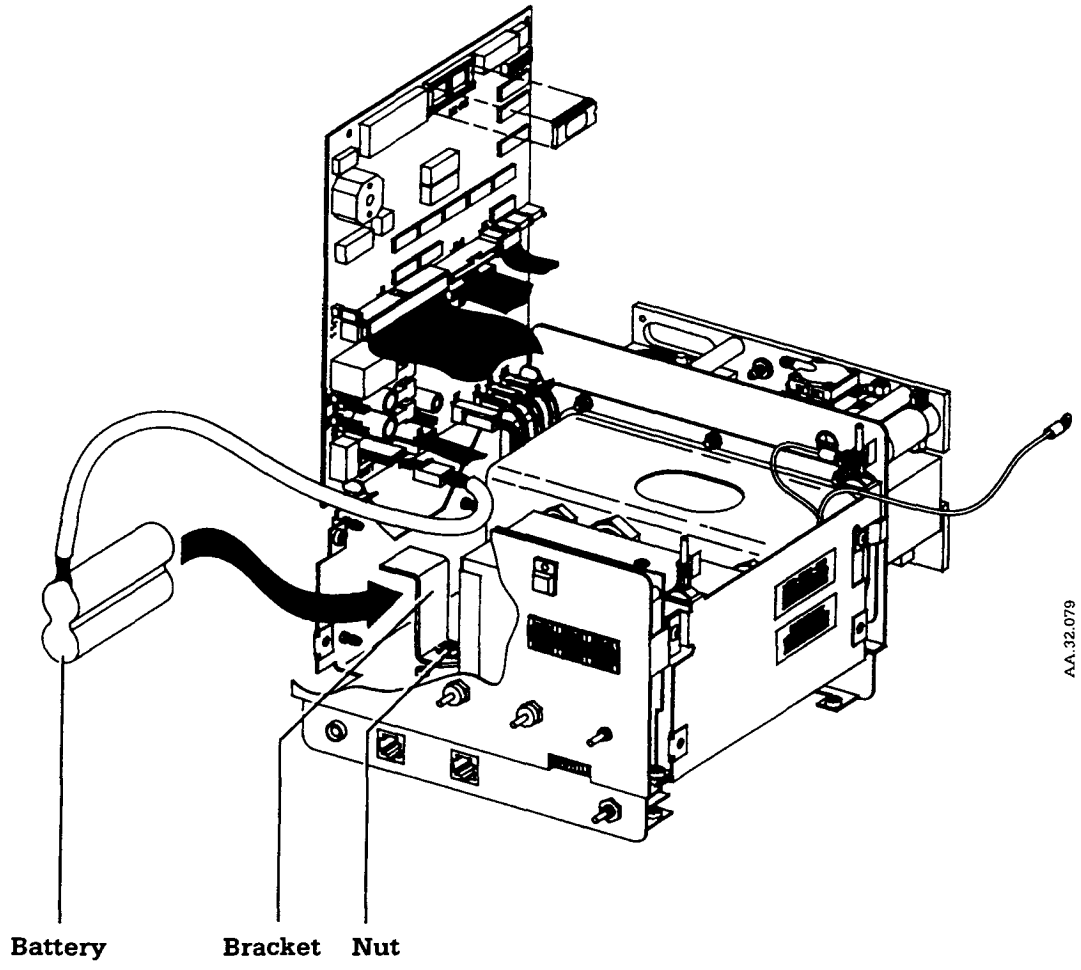

Figure 5-5 Battery

Testing After Maintenance

24. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

6/Troubleshooting

6.1 Troubleshooting Guide

Symptom	Probable Cause	Action
Bellows does not expand or tends to collapse during ventilation.	1. Leak in the breathing circuit.	1. Check breathing circuit and Absorber for leaks.
	2. Bellows not installed properly.	2. Check the Bellows to base attachment.
	3. Tear or leak in Bellows.	3. Check the entire surface of the Bellows. Pay close attention to the angles in the convolutions.
	4. Insufficient fresh gas flow.	4. Check that settings on flowmeters are adequate.
	5. Improperly functioning Pressure Relief valve.	5. Check Pressure Relief valve.
Bellows distended and/or slips off base.	1. Bellows retention problem.	1. Check Bellows.
	2. Bellows Assembly exhaust restricted.	2. Check the scavenging system for high vacuum or blockage.
	3. Bellows Assembly Pressure Relief valve problem.	3. Control port plugged or Drive Gas inlet hose blocked.

Symptom	Probable Cause	Action
Ventilator cycles normally but Low Pressure Alarm sounds continuously.	1. Pressure sensing tube disconnected, plugged or kinked.	1. Check the connections at the Control Module and at the connector.
Continuous flow of supply gas before machine is turned ON.	1. Internal hose leak.	1. Check hoses.
Bellows does not descend during inspiration.	1. APL/Bag - Vent Switch in APL/Bag Position.	1. Place the switch in the Vent Position.
	2. Drive Gas hose disconnected.	2. Reconnect Drive Gas hose.
	3. Failure of exhaust valve.	3. Check exhaust valve.
Volume readings are consistently low.	1. Volume sensor cartridge failed.	1. Replace the volume sensor cartridge.
System sounds alarms at incorrect pressures.	1. Liquid in pressure sensing tube.	1. Drain the sensing tube.
Reverse Flow Alarm is activated while the volume sensor is in the Distal position at the expiratory limb of the breathing circuit.	1. Volume monitor sensor clip is not placed in the proper flow direction.	1. Check placement of sensor clip.
	2. Expiratory check valve on absorber has stuck open.	2. Check the expiratory check valve on the Absorber for moisture or damaged disc.

Symptom	Probable Cause	Action
Alarms sound without apparent cause and cannot be silenced.	1. Microprocessor failure.	1. Replace Control Board.
No display on the LCD. No alarms sounding.	1. Anesthesia System power failure or Ventilator power disconnected.	1. Check power connections or Excel/Ventilator Interface cable.
	2. Circuit Breaker	2. The Circuit Breaker can be reset (without removing the cover) through a small hole in the bottom right side.
	3. +5 Power Supply, transformer, or cables.	3. Check plus (+)5 Vdc at J10, pin 12. If no +5 check fuses F1,F2, F3 on power supply board.
	4. Control Board analog power.	4. Check Fuses F102 and F103 on Control Board. Check plus (+)8.2 Vdc at J10, pin 4. Check minus (-)8.2 Vdc at J10, pin 6.
Settings do not meet Specifications.	1. Out of Calibration.	1. Recalibrate.

6.2 Ventilator Failure Messages

Symptom	Probable Cause	Action
VENT FAIL 0!	A/D Conversion timing failure.	Replace Control Board.
VENT FAIL 1!	CPU test failed.	Replace Control Board.
VENT FAIL 2!	EEPROM checksum or Write/Read failure.	Check EEPROM or replace Control Board.
VENT FAIL 3!	Write/Read failure (CPU internal RAM test).	Replace Control Board.
VENT FAIL 4!	Supply pressure greater than 207 kPa (30 psig).	Check regulator inlet pressure, or check regulator output pressure , or check calibration on the transducer board. Calibrate and check for drift in 30 minutes.
VENT FAIL 5!	No (plus) +5 Vdc from power supply and Low Battery voltage.	Check power connector. Check Anesthesia System power supply.
VENT FAIL 6!	Flow Valve failure.	Check Flow Valve, check calibration or replace Control Board.

Symptom	Probable Cause	Action
DRIVE CKT OPEN!	Water build up in the drive tube.	Check the drive circuit for fluid.
	Exhalation solenoid failure or drive circuit pressure too high.	Ensure J8 is plugged in. Check solenoid valves. Check ventilation/bag switch ON Absorber. Check press. switch or replace Control Board.
VENT FAIL 8!	Gas Inlet Valve failure.	Check Gas Inlet Valve or check solenoid valve. Ensure J9 is plugged in or replace Control Board.
VENT FAIL 9!	D/A conversion, patient pressure feedback error.	Check transducer PCB calibration or replace Control Board.
VENT FAIL 10!	Measured temperature = 0 (zero) or > 60° .	Check 10-pin ribbon cable connection or replace Pressure Transducer Board.
VENT FAIL 11!	+ 8.3 V dc supply is out of range.	Replace Control Board or replace Display Board or replace Pressure Transducer Board.
VENT FAIL 12!	Flow Valve table values corrupted.	Verify flow table section 4/Test and Calibration, or replace Control Board.

Symptom	Probable Cause	Action
VENT FAIL 13!	Undervoltage on +5 V dc.	Replace Power Supply.
VENT FAIL 14!	Overvoltage on +5 V dc.	Replace Power Supply.
VENT FAIL 15!	Auxiliary Port selected but French language not selected.	French must be selected on dual-port systems before you can select the auxiliary port.
VENT FAIL 16!	EPROM CRC failure.	Replace EPROM.
VENT FAIL 17!	D/A Conversion, O_2 feedback error.	Replace Control Board.
VENT FAIL 18!	(minus) -8.3 V dc supply out of range.	Replace Control Board or replace Display Board or replace Pressure Transducer Board.
VENT FAIL 19!	External RAM Write/Read failure.	Replace Control Board.
VENT FAIL 20!	Watchdog Circuit Failure.	Replace Control Board.
VENT FAIL 21!	Watchdog Circuit Failure.	Replace Control Board.

Symptom	Probable Cause	Action
HARDWARE ERROR A	Low O_2 thumbwheel switch reads non-decimal number.	Replace Front Panel board.
HARDWARE ERROR B	High O_2 thumbwheel switch reads non-decimal number.	Replace Front Panel board.
HARDWARE ERROR C	Volume O_2 thumbwheel switch reads non-decimal number.	Replace Front Panel board.
SOFTWARE ERROR A through SOFTWARE ERROR F	Software calculation Error.	Replace EPROM or replace Control Board.

Note: Operational alarm messages are found in the Operation and Maintenance manual.

7/Repair Procedures

7.0 General Information

The Ventilator can be an integral part of the Ohmeda Excel Anesthesia System, or attached to various other Anesthesia Systems. In some configurations it is possible to test and repair the Control Module while attached to the Anesthesia System. You must determine, if it is necessary to detach the Control Module in order to gain access for service or maintenance.

After servicing the ventilator, perform section "4/Test and Calibration" procedure to ensure that the Ventilator is completely operational.

⚠WARNING: Failure to perform section "4/Test and Calibration" could cause injury to the patient.

After performing section "4/Test and Calibration," perform section "3/Post Service Checkout."

⚠WARNING: Failure to perform section "3/Post-Service Checkout" before returning the system to clinical use, could cause injury to the patient.

⚠WARNING: Electrical Shock Hazard. Do not touch exposed wires or conductive surfaces while the panels are removed.

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

Ground Wires

The panels and covers in this Ventilator are interconnected, electrically, by heavy gauge ground wires. These wires may need to be removed to separate the panels. All ground wires must be reattached when assembling the Ventilator.

Lubricate O-rings

Apply a thin film of KRYTOX™ GPL 205 (oxygen-use-approved) lubricant as indicated to O-rings prior to installation.

KRYTOX™ is a Trademark of E.I. DuPont de Nemours Co. Inc.

7.1 Control Module Removal

The Control Module can be mounted on an optional arm, stand, or from a system shelf.

A. Shelf Mounting

The Comtrol Module may be mounted to the top shelf directly or by using a mounting box. The mounting box attaches the Control Module to three (3) different types of Excel top shelves.

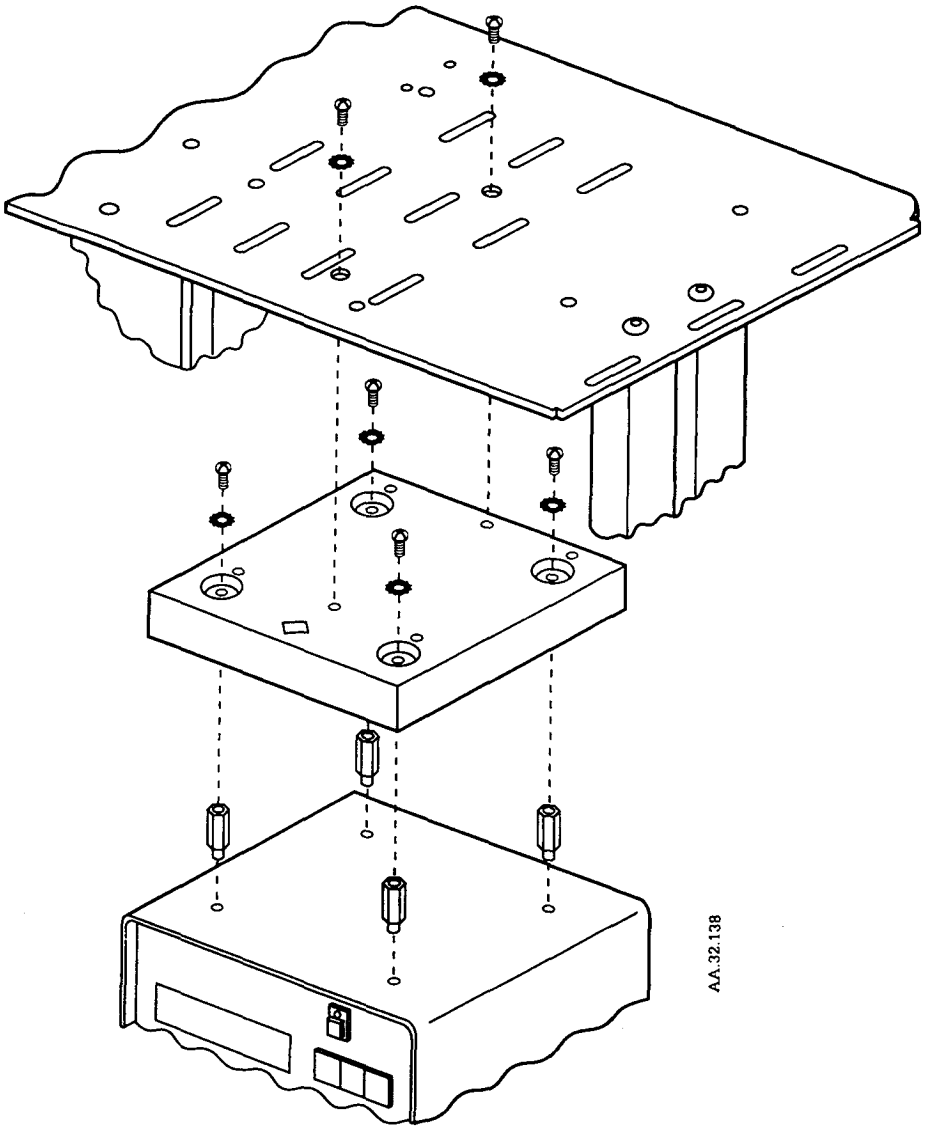

Figure 7-1 Shelf Mounting, Configuration A

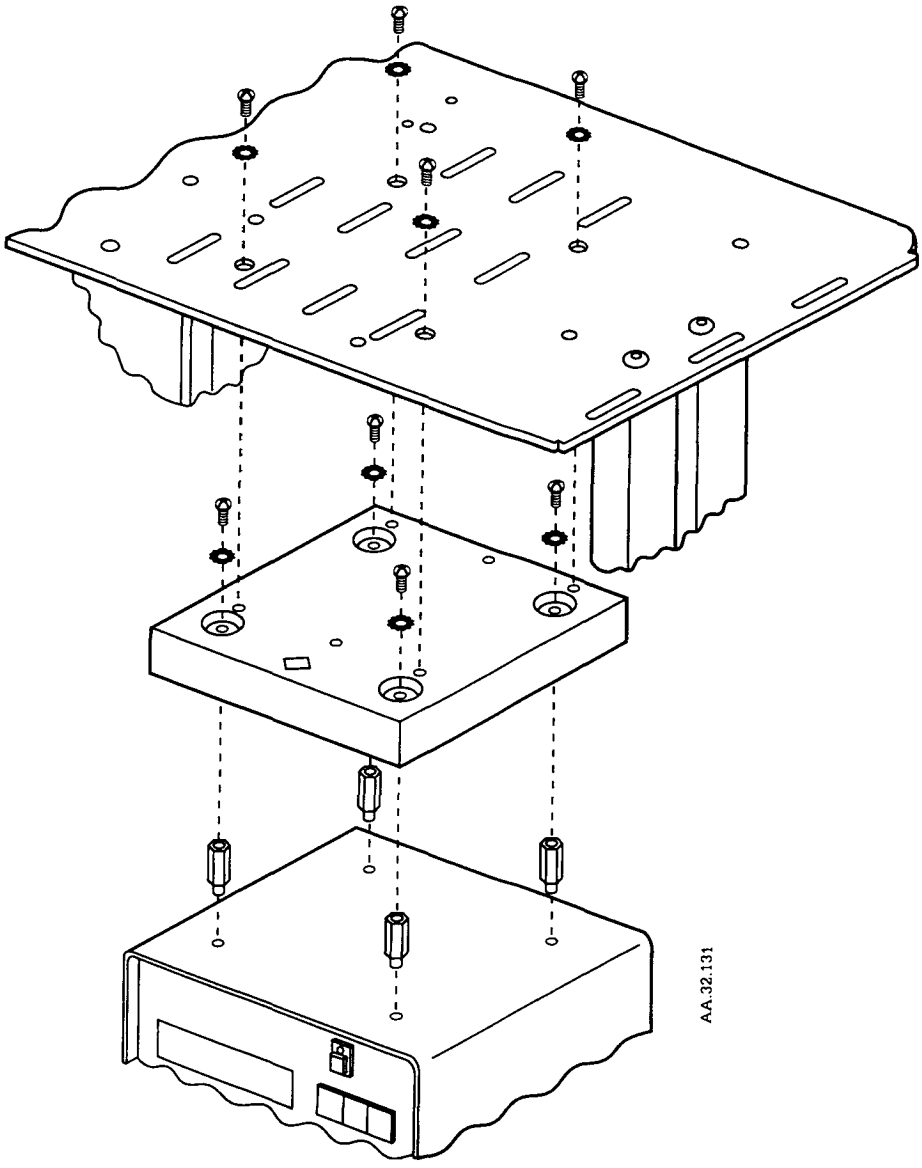

Figure 7-2 Shelf Mounting, Configuration B

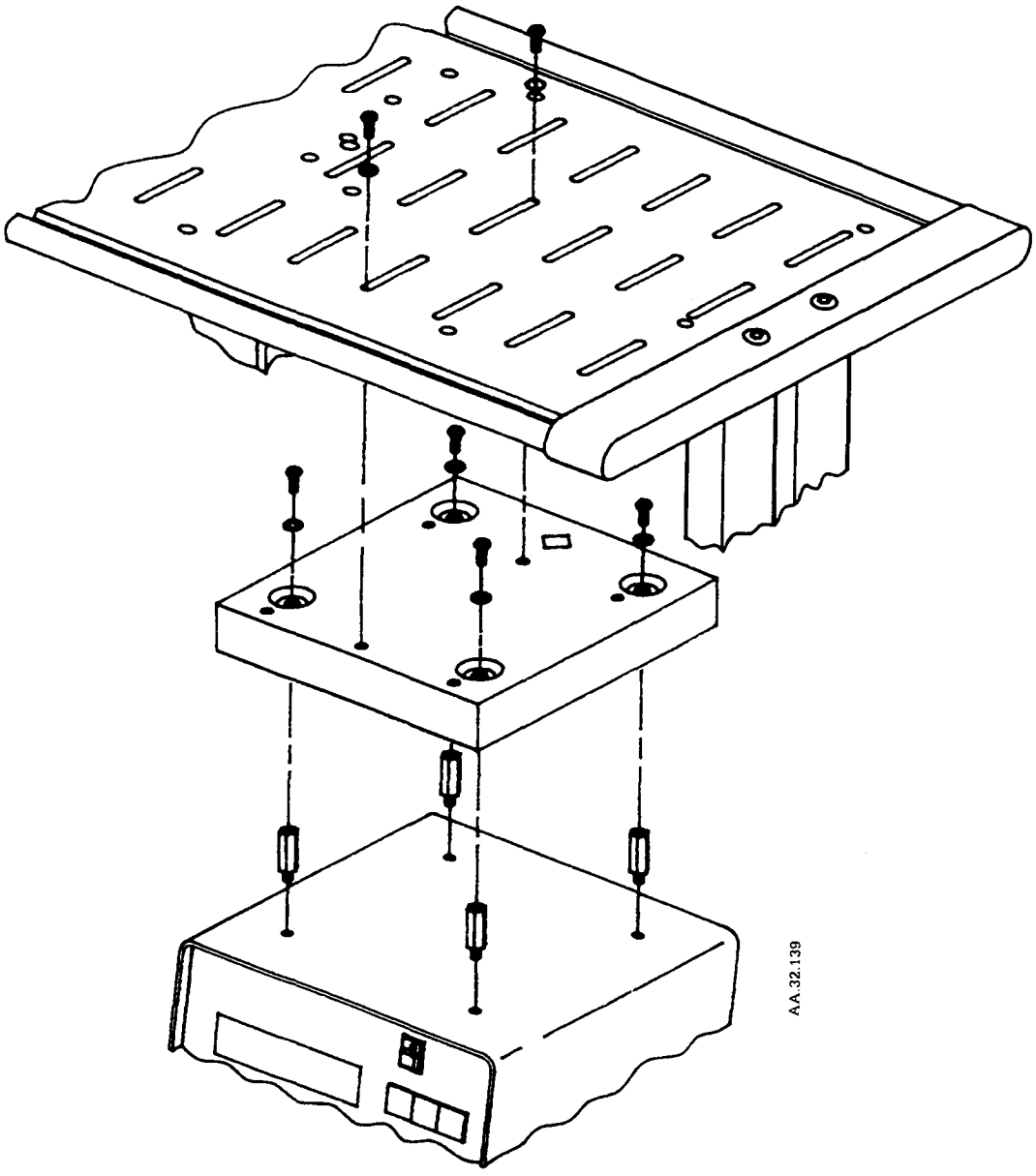

Figure 7-3 Shelf Mounting, Configuration C

B. Optional Arm Mounting

The Control Module is secured to the arm by three (3) screws.

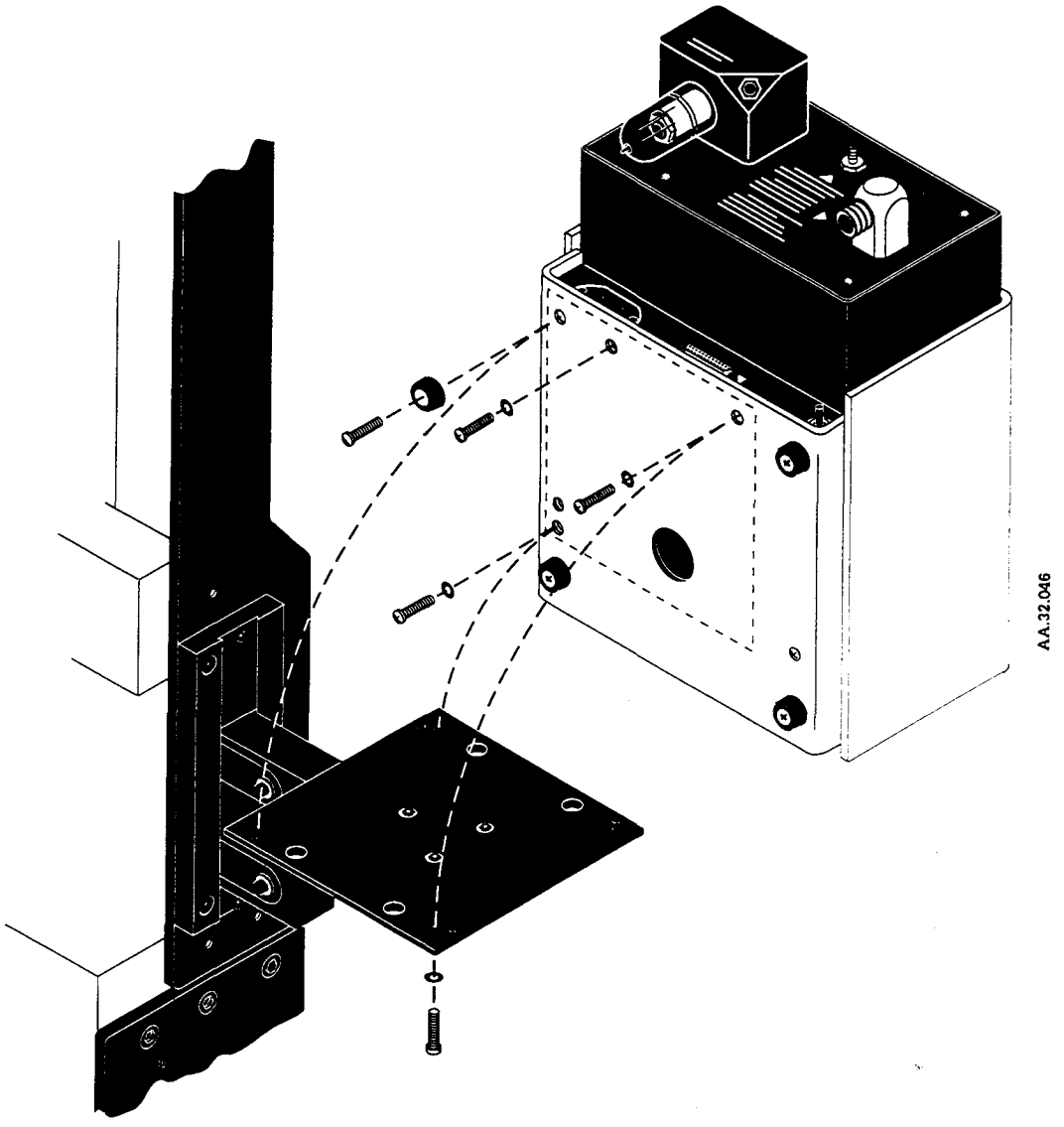

Figure 7-4 Optional Arm Mounting

7.2 Major Assembly Replacement

A. Control Board and EPROM Replacement

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

Important: The Control Board jumper configuration for 7800 use is: J11 installed; J4, J14, J15 and J17 removed.

Removal:

1. Remove the Control Board and place on an anti-static surface.
2. Remove the socketed 28-pin EPROM, U112 (Control Board) and move to the replacement board.

   Important: The socket is larger than the EPROM, so the pins must be offset by two. Pin one (1) goes into position three (3).
3. Remove the socketed 8-pin EEPROM, U114 (Control Board). Move to the replacement board.

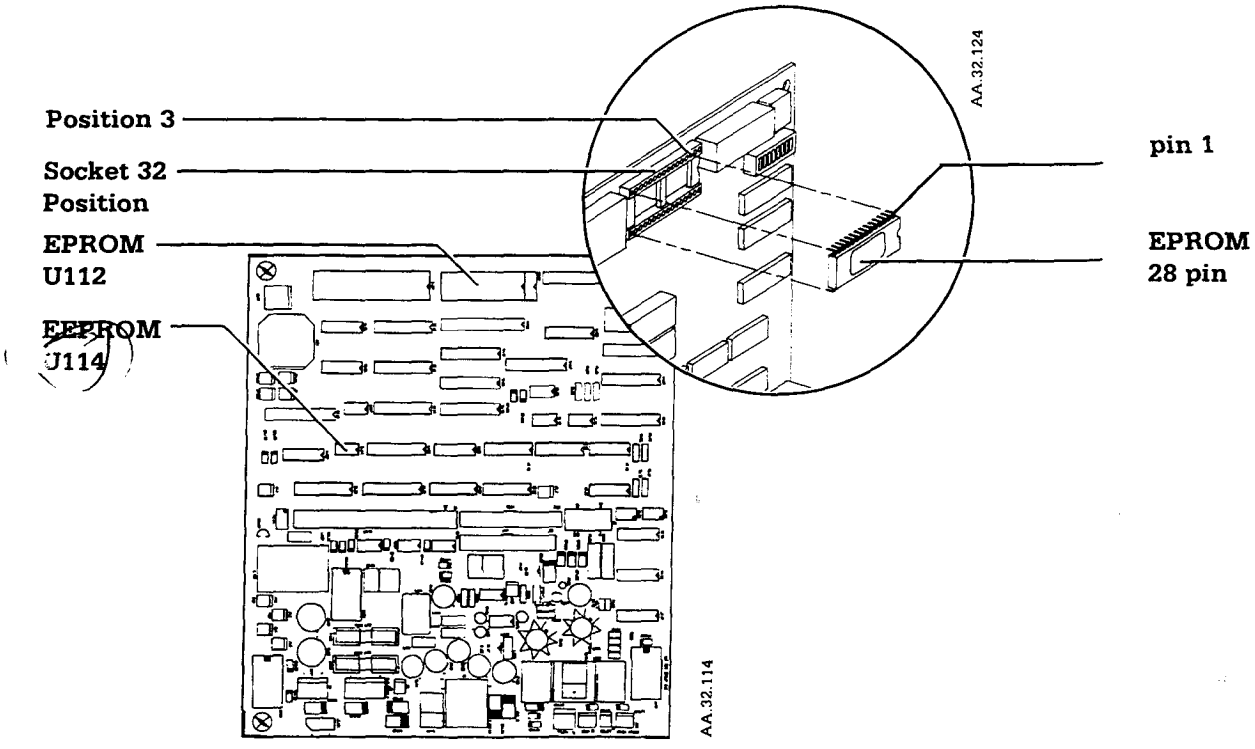

Figure 7-5 EPROM and EEPROM Location

Installation:

1. Install the Control Board and connect the cables.

    - J2 (Battery Pack)
    - J3 (Power Supply)
    - J7 (Flow Control Valve) Red, Black
    - J8 (Exhalation Solenoid, SOL 1) Green, Orange
    - J9 (Inlet Solenoid, SOL 2) Blue, Red
    - J16 (High Pressure Limit Switch) Yellow, Violet
    - J1 (Front Panel board) 50 position ribbon
    - J5 (Serial Interface)
    - J6 (Pressure Transducer board) 10 position ribbon
    - Ground wire (to chassis ground cluster)

2. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

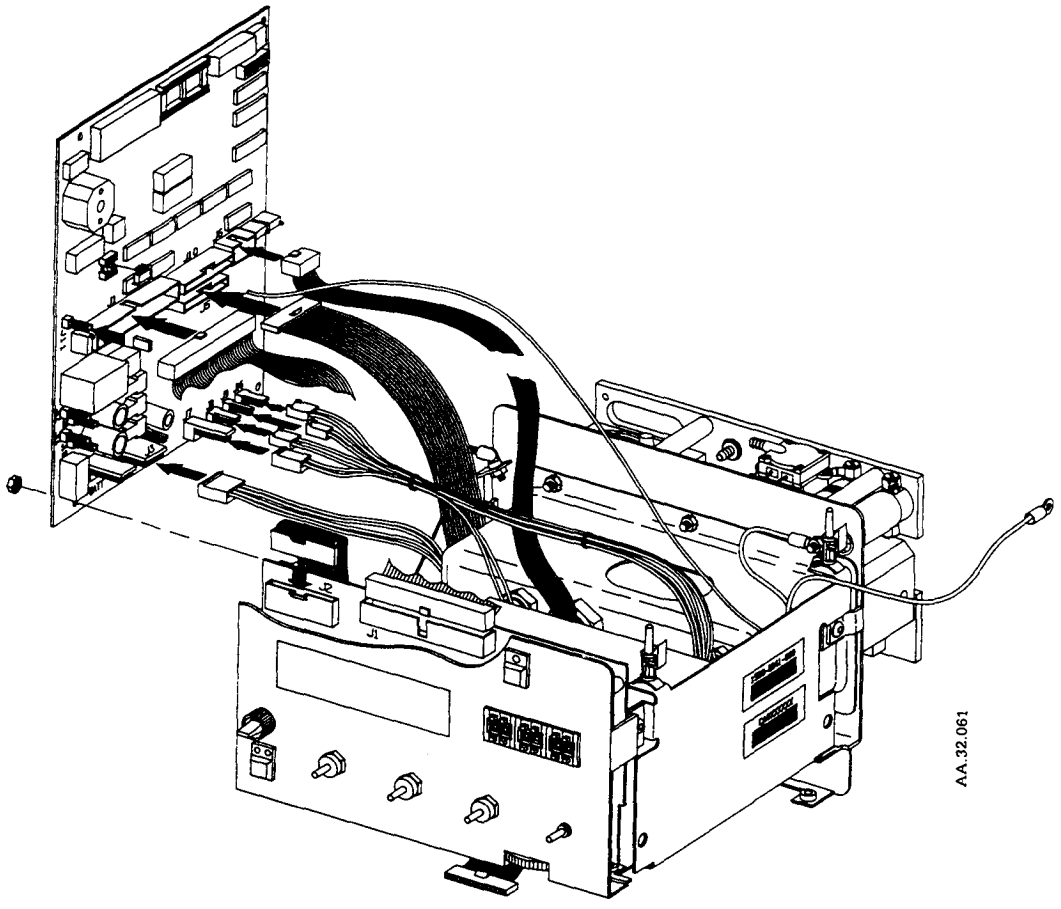

Figure 7-6 Control Board

B. Front Panel Board Replacement

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

Removal:

In order to remove the Front Panel board you must remove the Lower Shroud, the Lower Front Panel and the entire Front Panel Assembly. The Front Panel board is attached by screws, torque nuts and a switch guard.

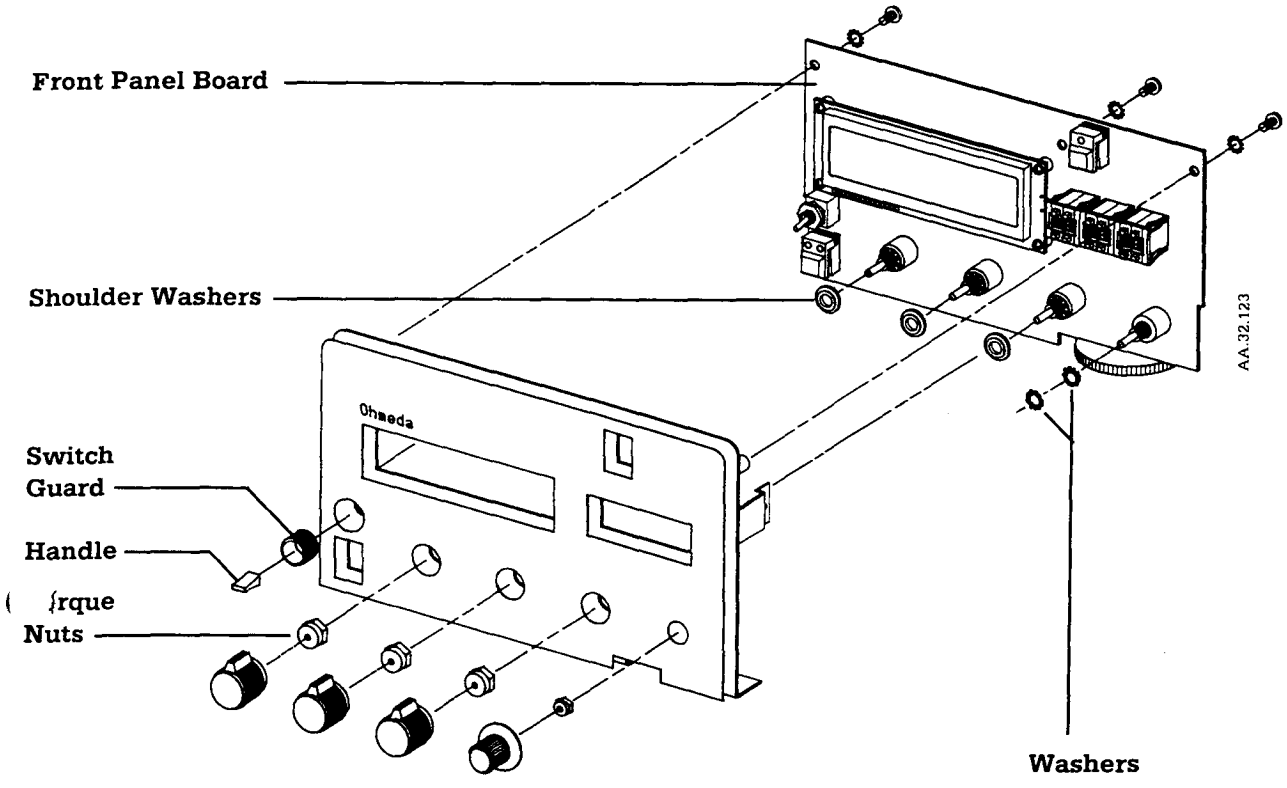

Figure 7-7 Removing Front Panel

Installation:

1. Install the three (3) shoulder washers onto the replacement board.
2. Install the two (2) washers onto the Inspiratory Pressure Limit shaft.
3. Insert the right side of the Front Panel board (as viewed from the front) into the sheet metal. Snap the board in place.
4. Install the torque nuts. Do not over tighten.
5. Install the switch guard and press on the handle.
6. Attach the screws and washers that hold the circuit board in place.
7. Attach the Front Panel Assembly, the Lower Front Panel and the Lower Shroud.
8. Connect the cables.
   - J1 (Control Board) 50 position ribbon
   - J2 (EMC/Interface board)
   - J8 (Speaker)
9. The knobs will be installed and adjusted when you perform section "4/Test and Calibration."
10. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

C. Pressure Transducer Board Replacement

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

Removal:

In order to remove the Pressure Transducer board you must remove the Inlet block, the Pneumatic Cover and the entire Pneumatic Mounting Plate assembly. The Pressure Transducer board is attached by snap top standoffs.

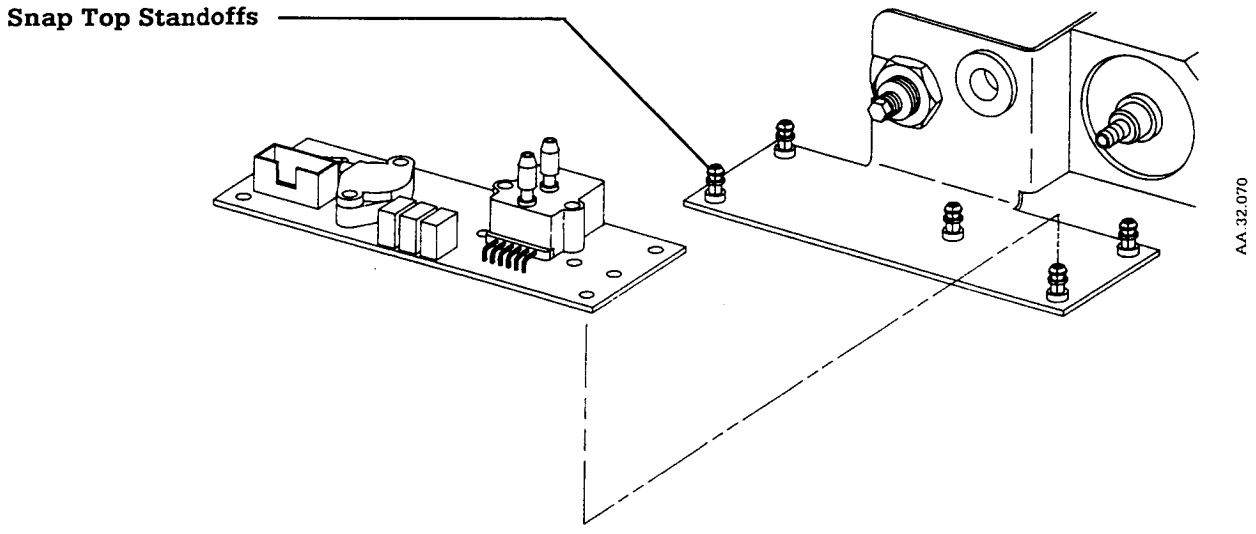

Figure 7-8 Pressure Transducer board Removal

Installation:

1. Position the board and press into place.
2. Connect the ten (10) position ribbon cable.
3. Attach the green hose to "B" port of U4 (High Pressure Transducer). Attach the clear tubing to U5 (Low Pressure Transducer).
4. Connect the Header board cables.
   - J1 (Control Board) Red, Black
   - J2 (Control Board) multi-color
5. Attach the Pneumatic Mounting Plate assembly, the Pneumatic Cover and the Inlet Block.
6. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

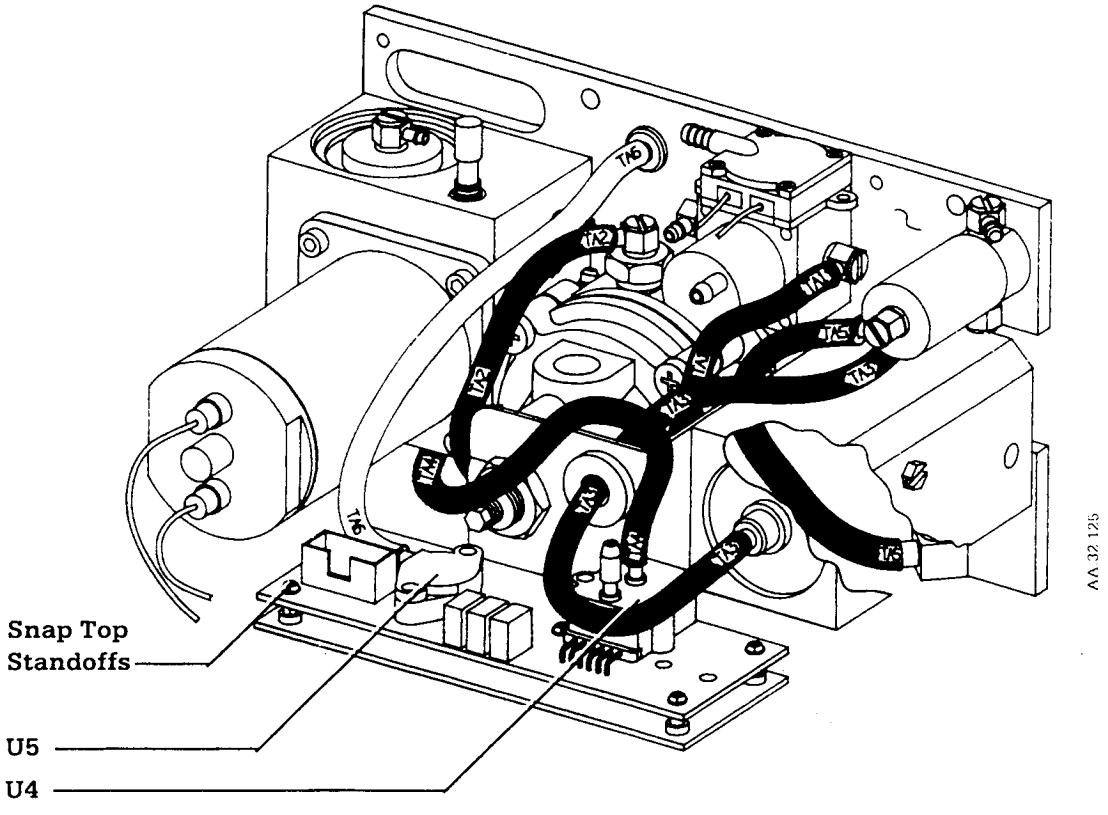

Figure 7-9 Pressure Transducer board Installation

D. Power Supply Board Replacement

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

Removal:

In order to remove the Power Supply board you must remove the Lower Shroud.

Installation:

1. Align the insulator and attached the box assembly.

3. Connect the cables.
   - J1 (Transformer)
   - J2 (Control Board)
   - J3 (Mains indicator)

4. Attach the Lower Shroud.

5. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

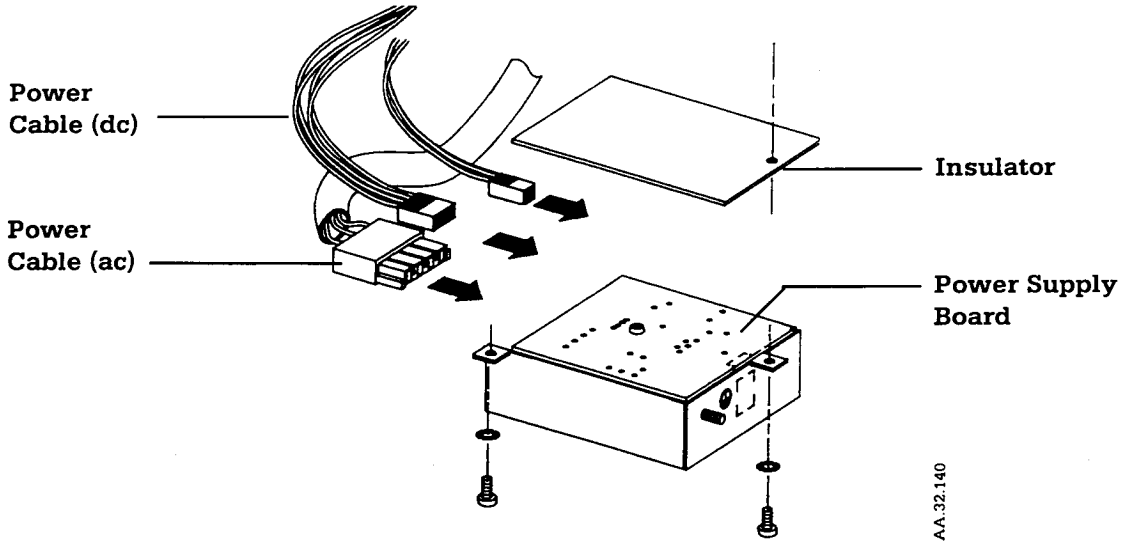

Figure 7-10 Power Supply Board Replacement

E. Header Board Replacement

Removal:

In order to remove the Header Board you must remove the Inlet block, the Pneumatic Cover and the entire Pneumatic Mounting Plate assembly.

Installation:

1. Mount the Header board.
2. Connect the cables.
   - J7 (Flow Control Valve)
   - J8 (Exhalation Solenoid)
   - J9 (Inlet Solenoid)
   - J16 (High Pressure Limit Switch)
   - J1 (Control Board) Red, Black
   - J2 (Control Board) Multi-color

   Note: The J8 and J16 connectors are the same size. Do not reverse.
3. Attach the Pneumatic Mounting Plate assembly, the Pneumatic Cover and the Inlet Block.
4. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

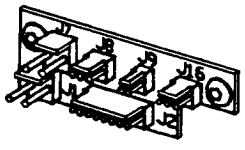

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Figure 7-11 Header Board

F. EMC/Interface Board Replacement

Removal:

In order to remove the EMC/Interface board you must remove the Lower Shroud and the Lower Front Panel. The board is attached by three (3) screws.

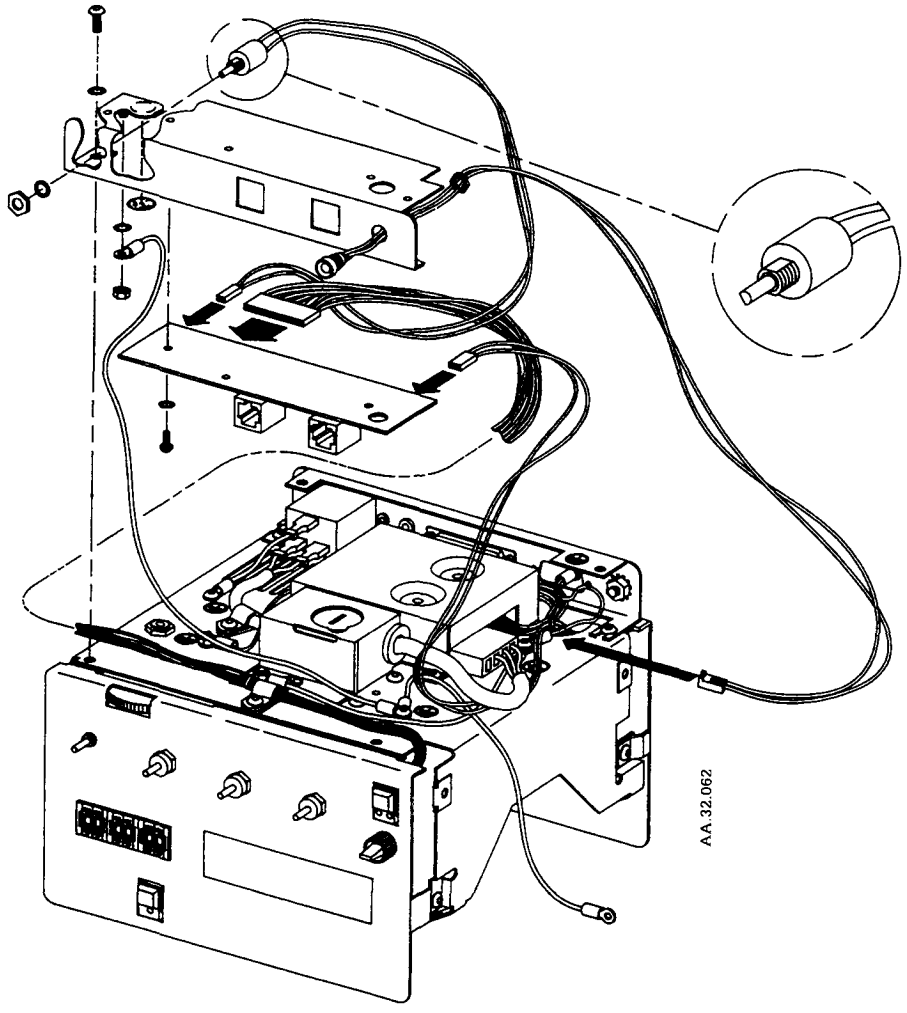


Figure 7-12 EMC/Interface Board, Stand alone

Installation:

1. Mount the EMC/Interface board in the Lower Front Panel.
2. Connect the cables.
   - P1 (Control Board) Serial Interface
   - P2 (Sensor/Remote) Excel Mount Only
   - P3 (Front Panel)
   - P4 (ON/Standby) Stand alone Only
3. Attach the Lower Front Panel and Lower Shroud.
4. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

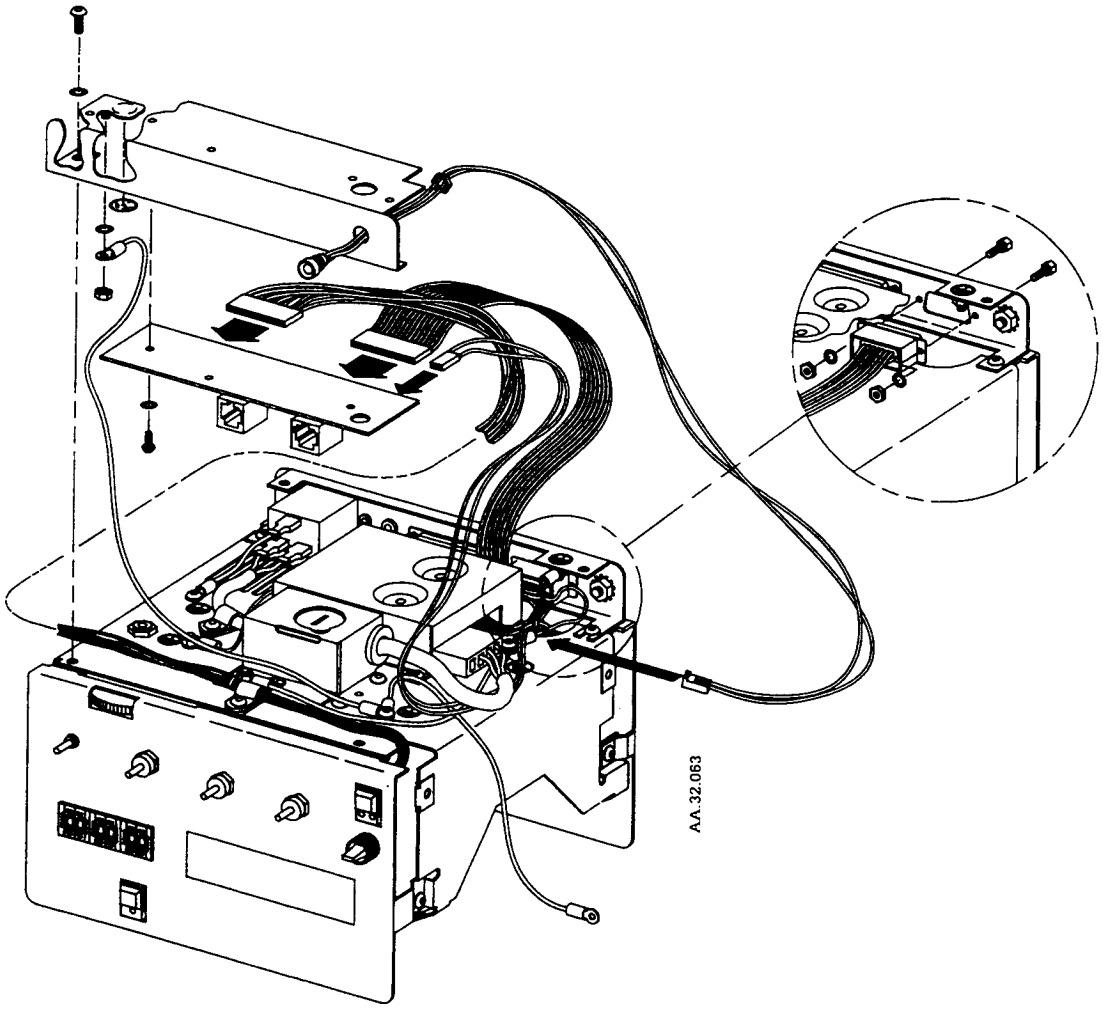


Figure 7-13 EMC/Interface Board, Excel Mount

G. Primary Regulator Replacement

Removal:

In order to remove the Primary Regulator you must remove the Inlet block, the Pneumatic Cover and the entire Pneumatic Mounting Plate assembly. The Primary Regulator and Gas Inlet Valve are held together by a bracket.

1. Remove the screws that mount the Gas Inlet Valve and the Pneumatic Manifold Assembly.

2. Separate the Gas Inlet Valve and Primary Regulator away from the Pneumatic Manifold Assembly.

3. Loosen the jam-nut on the Primary Regulator and slide out and away from the Gas Inlet Valve.

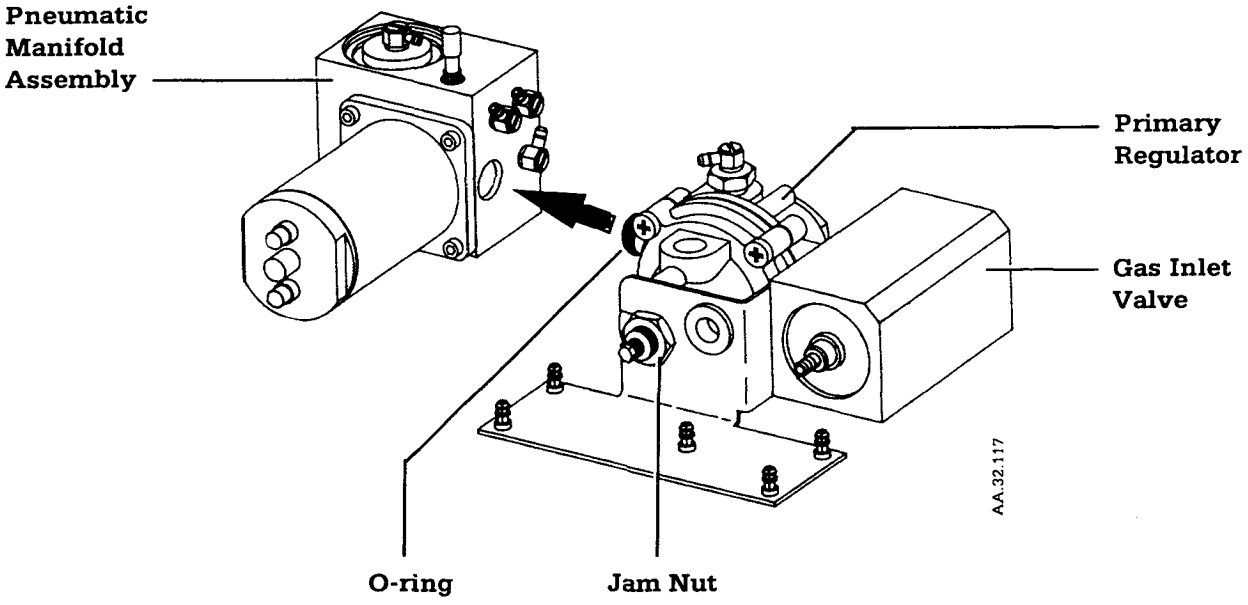


Figure 7-14 Primary Regulator and Gas Inlet Valve

Installation:

1. Lubricate both O-rings on the Primary Regulator. Use a thin film of KRYTOX™ (oxygen-use-approved) lubricant.
2. Move the Primary Regulator into position and tighten the jam-nut.
3. Align the Gas Inlet Valve and Primary Regulator with the Pneumatic Manifold Assembly. Mount the Pneumatic Manifold Assembly with the gasket in place. Mount the Gas Inlet Valve.
4. Attach the hose, TA2 (Filter) Green.
5. Connect the Header board cables.
   - J1 (Control Board) Red, Black
   - J2 (Control Board) multi-color
6. Attach the Pneumatic Mounting Plate assembly, the Pneumatic Cover and the Inlet Block.
7. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

H. Pneumatic Manifold Assembly and EEPROM Replacement

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

The Pneumatic Manifold Assembly and matched EEPROM must be replaced together. The EEPROM contains the Pneumatic Manifold calibration numbers, and user parameters. When you replace the EEPROM, the new EEPROM will have only the new Pneumatic Manifold calibration numbers. You must record the original user parameters and transfer this information to the new EEPROM.

Removal:

1. Record the current parameter settings. You will enter these parameters when you perform section "4/Test and Calibration."

   - Ventilator Model — 7800
   - Software Revision Number — xx.xx
   - Supply Gas selection — O_2 or AIR
   - Language — _____
   - Altitude — xxxx meters
   - Reverse Flow Alarm — ON or OFF
   - SIGH — ON or OFF
   - Contrast — number xx
   - Audio Volume — number xx

2. Remove the Inlet Block, Pneumatic Cover and Pneumatic Mounting Plate assembly.

3. Remove the screws that mount the Gas Inlet Valve and the Pneumatic Manifold Assembly.

4. Seperate the Pneumatic Manifold Assembly away from the regulator.

H. Pneumatic Manifold Assembly and EEPROM Replacement

⚠CAUTION: Avoid static. Wear an anti static wrist strap when handling static sensitive components. Some parts can be damaged by improper handling.

The Pneumatic Manifold Assembly and matched EEPROM must be replaced together. The EEPROM contains the Pneumatic Manifold calibration numbers, and user parameters. When you replace the EEPROM, the new EEPROM will have only the new Pneumatic Manifold calibration numbers. You must record the original user parameters and transfer this information to the new EEPROM.

Removal:

1. Record the current parameter settings. You will enter these parameters when you perform section "4/Test and Calibration."

   - Ventilator Model — 7800
   - Software Revision Number — xx.xx
   - Supply Gas selection — O_2 or AIR
   - Language — _____
   - Altitude — xxxx meters
   - Reverse Flow Alarm — ON or OFF
   - SIGH — ON or OFF
   - Contrast — number xx
   - Audio Volume — number xx

2. Remove the Inlet Block, Pneumatic Cover and Pneumatic Mounting Plate assembly.

3. Remove the screws that mount the Gas Inlet Valve and the Pneumatic Manifold Assembly.

4. Seperate the Pneumatic Manifold Assembly away from the regulator.

Installation:

1. Install the Pneumatic Manifold Assembly with the gasket in place.
2. Mount the Gas Inlet Valve.
3. Attach the hose, tubing.
   - TA4 (High Pressure Transducer) Green
   - TA8 (High Pressure Limit Switch) Clear
   - TA9 (Exhaust Tee) Clear
   - TA10 (Secondary Regulator) Clear
   - TA7 (Exhalation Solenoid) Clear

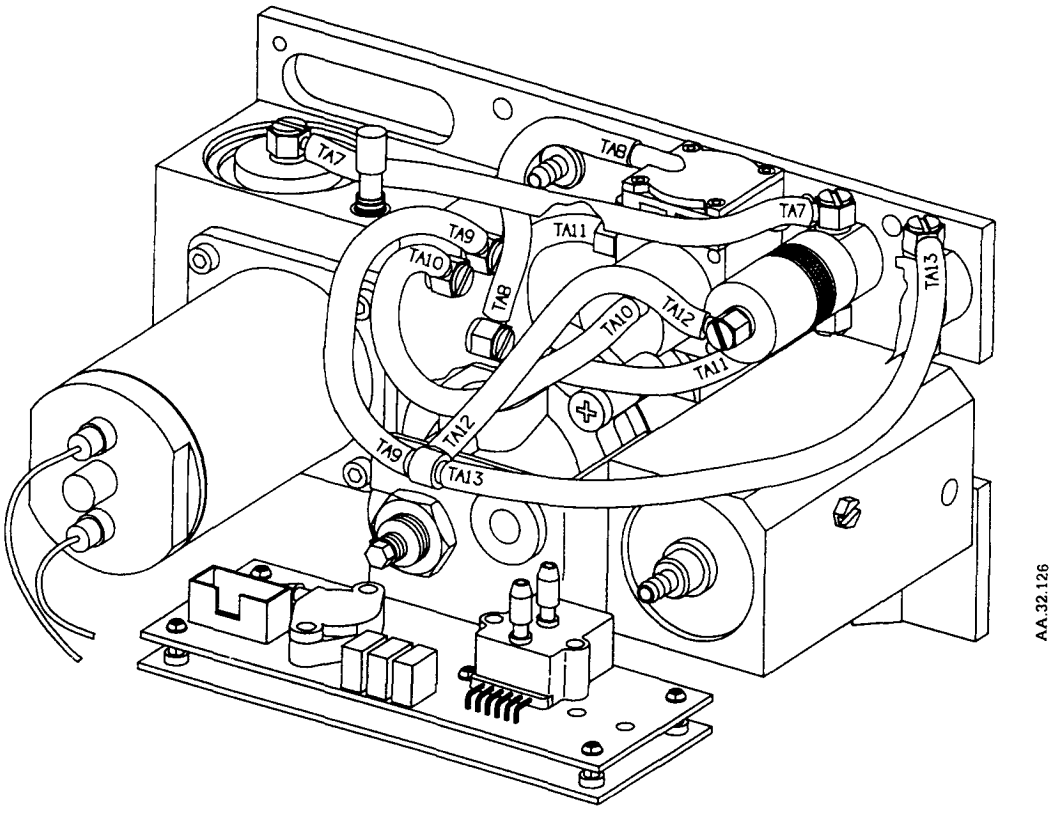


Figure 7-15 Tubes TA7-TA13

4. Connect the Header board cables.
   - J1 (Control Board) Red, Black
   - J2 (Control Board) multi-color
   - J7 (Header board) Flow Control Valve

5. Attach the Pneumatic Mounting Plate assembly, the Pneumatic Cover and the Inlet Block.

6. Replace the socketed 8 pin EEPROM, U114 (Control Board).

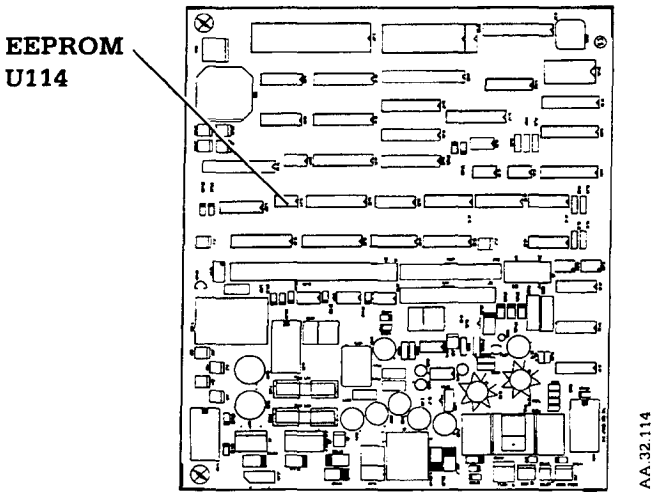


Figure 7-16 *EEPROM Location*

7. Perform section "4/Test and Calibration" and then section "3/Post-Service Checkout."

8.0 General Information

The illustrated parts in this section are subject to change at any time without notice.

⚠WARNING: Complete section "3/Post Service Checkout," after performing any maintenance or service. Failure to do so could result in injury to the patient.

⚠CAUTION: Wear a grounding wrist strap when handling static sensitive assemblies.

Special Instructions

Apply a thin coat of oxygen-use-approved lubricant to O-rings prior to installation (unless otherwise noted). Use:

- KRYTOX™ GPL 205, Ohmeda Stock Number — 1001-3854-000

All pipe thread joints should have pipe seal applied when assembling, unless otherwise noted. Teflon™ pipe seal tape is not allowed. Use:

- Loctite™ #59231, thread seal, Ohmeda Stock Number — 0220-5006-300

Some screws require an anti-loosening bond. Use:

- Loctite™ #24231, screw lock, Ohmeda Stock Number — 0220-5016-300

When replacing fittings, position the barb end in the same direction as the original fitting to make hose connections easier.

KRYTOX™, Teflon™ and Loctite™ are Trademarks of E.I. DuPont de Nemours Co. Inc.

Major Assemblies

Circuit Board Assemblies	Stock Number
• 64K Control Board; without EEPROM and EPROM	1500-8027-000
• Pressure Transducer Board	1500-8024-000
• Power Supply Board	1500-7059-000
• Front Panel Board	1500-8022-000
• EMC/Interface Board	1500-3315-000
• Header Board	1500-3257-000

Software	Stock Number
• 64K EPROM Kit, English version 4.20	1500-8020-000
• 64K EPROM Kit, French version 4.20	1500-8053-000
• 64K EPROM Kit, German version 4.20	1500-8054-000
• 64K EPROM Kit, Italian version 4.20	1500-8055-000
• 64K EPROM Kit, Swedish version 4.20	1500-8056-000
• 64K EPROM Kit, Spanish version 4.20	1500-8057-000

Pneumatic Assemblies	Stock Number
• Primary Regulator Assembly; includes O-rings (2), Adapters (2), Elbow Fitting	1500-7071-000
• Secondary Regulator Assembly, with fittings	1500-7072-000
• High Pressure Limit Switch, includes adhesive tape	1500-3132-000
• EEPROM and Pneumatic Manifold Assembly, available only as a matched pair	1500-8023-000
• Solenoid 2, Gas Inlet Valve	1500-7073-000
• Solenoid 1, Exhalation Valve	1500-7074-000

Maintenance Kits	Stock Number
• Yearly Ventilator Maintenance Kit	1500-8036-000
• Gas Supply Filter Maintenance Kit	1500-3320-000
• Gas Supply Filter and Bowl Replacement Kit	1500-3319-000

8.1 Assemblies and Components

Non-Autoclavable Bellows Assembly

⚠**CAUTION: Do not autoclave any of the Non-Autoclavable Bellows Assembly components. The Non-ABA components are not designed to withstand high temperatures. Damage to the components and Autoclave may occur.**

⚠**CAUTION: Parts for the Non-Autoclavable Bellows Assemblies are not interchangeable with the Autoclavable Bellows Assembly (ABA).**

Description	Stock Number	Quantity
1. Adult Bellows Housing, Non-Autoclavable	1500-3225-000	
2. Adult Bellows, Non-Autoclavable	0229-1013-700	
3. Seal, U-cup, for Bellows Housing, Non-Autoclavable	0210-0784-300	
4. Pop-off Thumbscrew, 6-32 inch thread	0400-3507-300	(3)
5. Pop-off Valve Assembly	0229-1029-800	
6. Bellows Base, Non-Autoclavable	0229-0060-100	
7. Label, Port I.D.	1500-3371-000	
8. 'O'-Ring, for Pop-off valve, Do Not Lubricate O-Ring	1500-3267-000	
9. Pediatric Bellows mounting ring and retainer, Non-Autoclavable	0229-1023-700	
10. Pediatric Bellows, Non-Autoclavable	0229-1018-700	
11. Bellows Thumbscrew, 10-32 inch thread	0400-3524-300	(4)
12. Pediatric Bellows Housing, Non-Autoclavable	1500-3215-000	

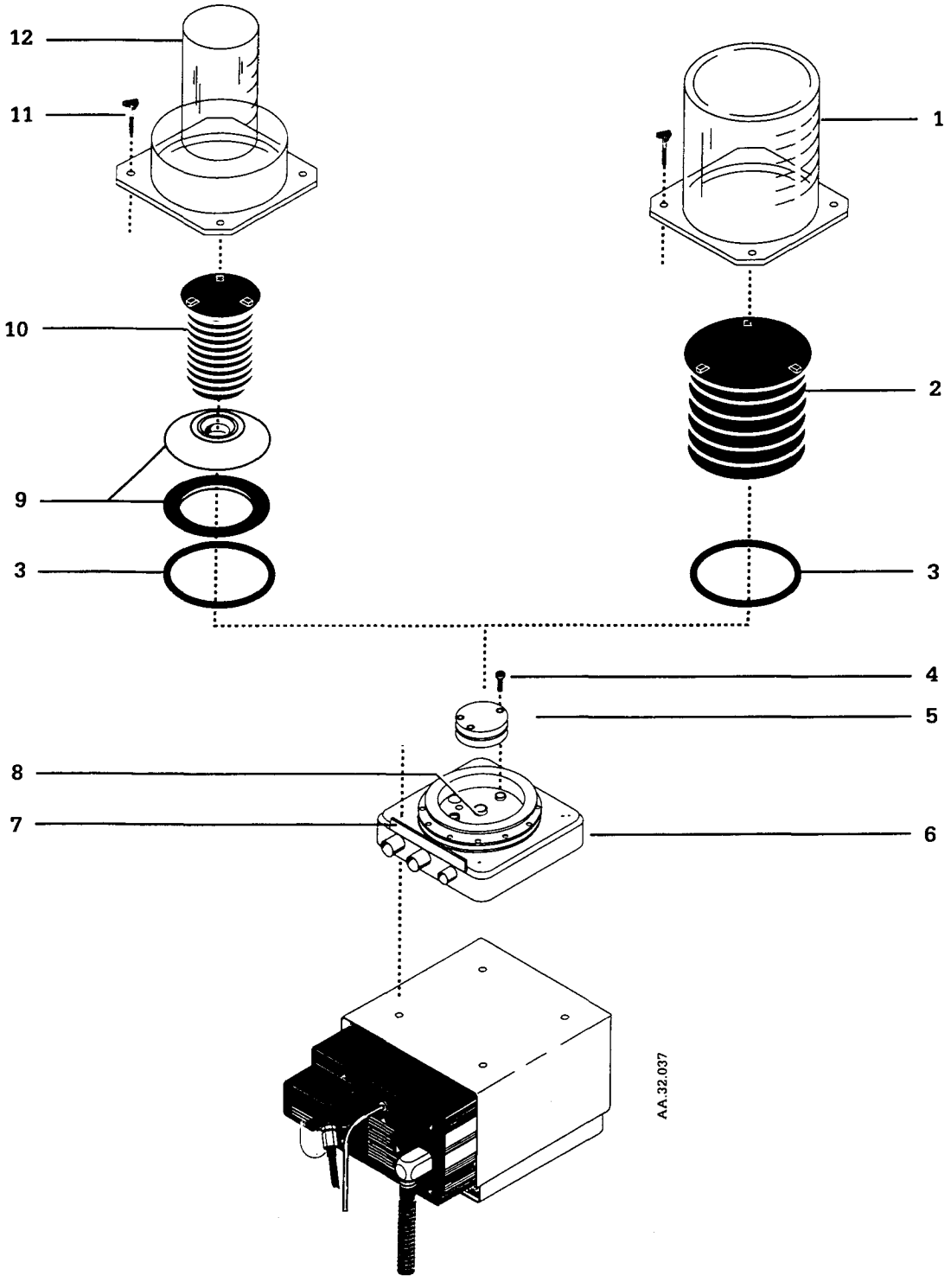


Figure 8-1 Adult and Pediatric Bellows Assembly, Non-Autoclavable

Autoclavable Bellows Assembly

⚠**CAUTION: Parts for the Non-Autoclavable Bellows Assemblies are not interchangeable with the Autoclavable Bellows Assembly (ABA).**

Description	Stock Number	Quantity
1. Adult Bellows Housing, Autoclavable	1500-3117-000	
2. Adult Bellows, Autoclavable	1500-3378-000	
3. Rim, for Bellows Base, Autoclavable	1500-3351-000	
4. Diaphragm and Seat Assembly, Autoclavable	1500-3377-000	
5. Latch, Autoclavable	1500-3352-000	
6. Seal, Autoclavable	1500-3359-000	
7. Bellows Base, Autoclavable	1500-3350-000	
8. Mounting Plate	1500-3379-000	
9. Mounting Screw, 10-32 x 1/2 inch, stainless steel,	0140-6631-109	(4)
10. Disk/Ring/Bumper Assembly, for Bellows, not shown	1500-3381-000	

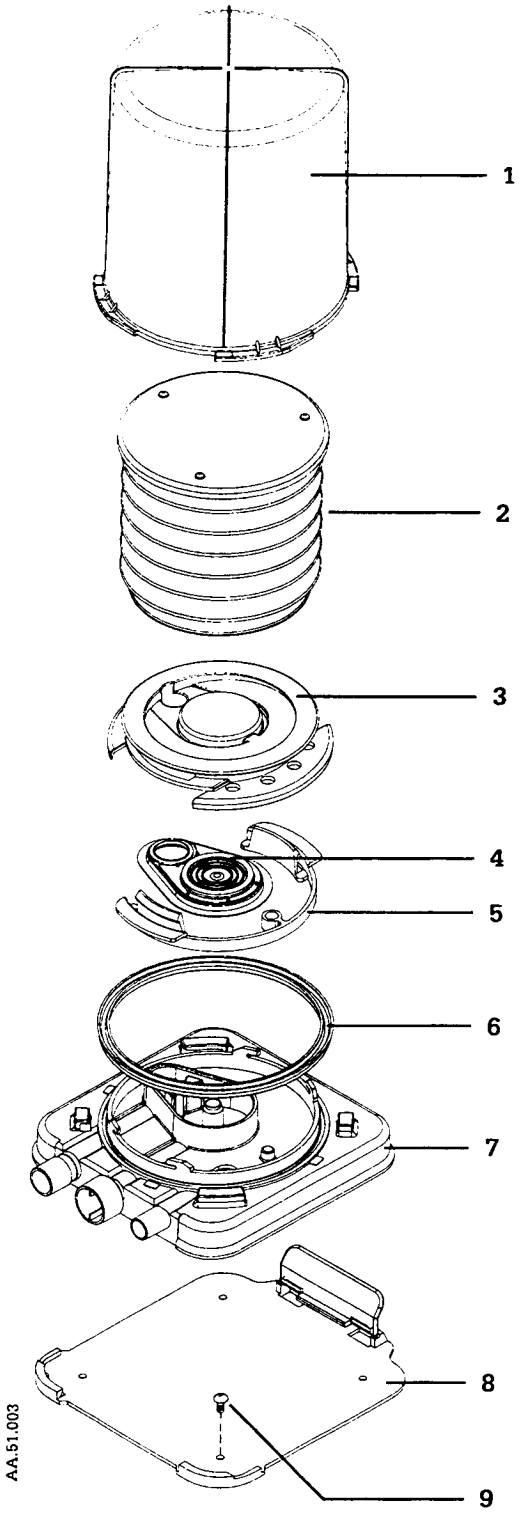


Figure 8-2 Adult Bellows Assembly, Autoclavable

Primary Regulator and Gas Inlet Valve

Description	Stock Number	Quantity
1. 'O'-Ring, Gas Supply Inlet*	9211-3009-624	
2. Adapter, Gas Supply Inlet	1500-5117-000	
3. Gas Inlet Valve Body, with Cap	1500-8075-000	
4. Plug	1500-3272-000	
5. Elbow Fitting, 1/8 inch NPT male to 1/8 inch barb	0204-8788-300	
6. 'U' Cup Seal*, Inlet Valve, Second	See Maintenance Kit	
7. 'O'-Ring*, Inlet Valve, Second	See Maintenance Kit	
8. Retaining Ring, TRUARC, 34.9 mm housing	1500-3158-000	
9. Inlet Valve Cap	1500-5064-000	
10. 'O'-Ring*, Inlet Valve, First	See Maintenance Kit	
11. 'U' Cup Seal*, Inlet Valve, First	See Maintenance Kit	
12. Inlet Valve (Spoppet)	1500-5019-000	
13. Grommet, Regulator Support Bracket	1001-3958-000	
14. Primary Regulator Assembly; includes O-rings (2), Adapter (2), Elbow Fitting	1500-7071-000	
15. Screw, M4 x 6, Button Head, stainless steel	9211-1040-067	(2)
16. Washer, external lock, M4	9213-0540-003	(2)
17. Regulator Support Bracket, International	1500-5099-000	

Note: * Apply a thin film of KRYTOX™ GPL 205, an oxygen-use-approved lubricant.

arly Ventilator Maintenance Kit—1500-8036-000— includes:

- Exhalation Diaphragm
- 'O'-Ring, for the Exhalation Diaphragm Retainer and Sleeve
- Free Breathing Valve
- 'O'-Ring, for the Free Breathing Valve seat
- First 'O'-Ring (Large), for the Inlet Valve Cap *
- First 'U' Cup Seal (Large), for the Spoppet *
- Second 'O'-Ring (Small), for the Inlet Valve Body *
- Second 'U' Cup Seal (Small), for the Inlet Valve Body *
- 5 micron Filter assembly

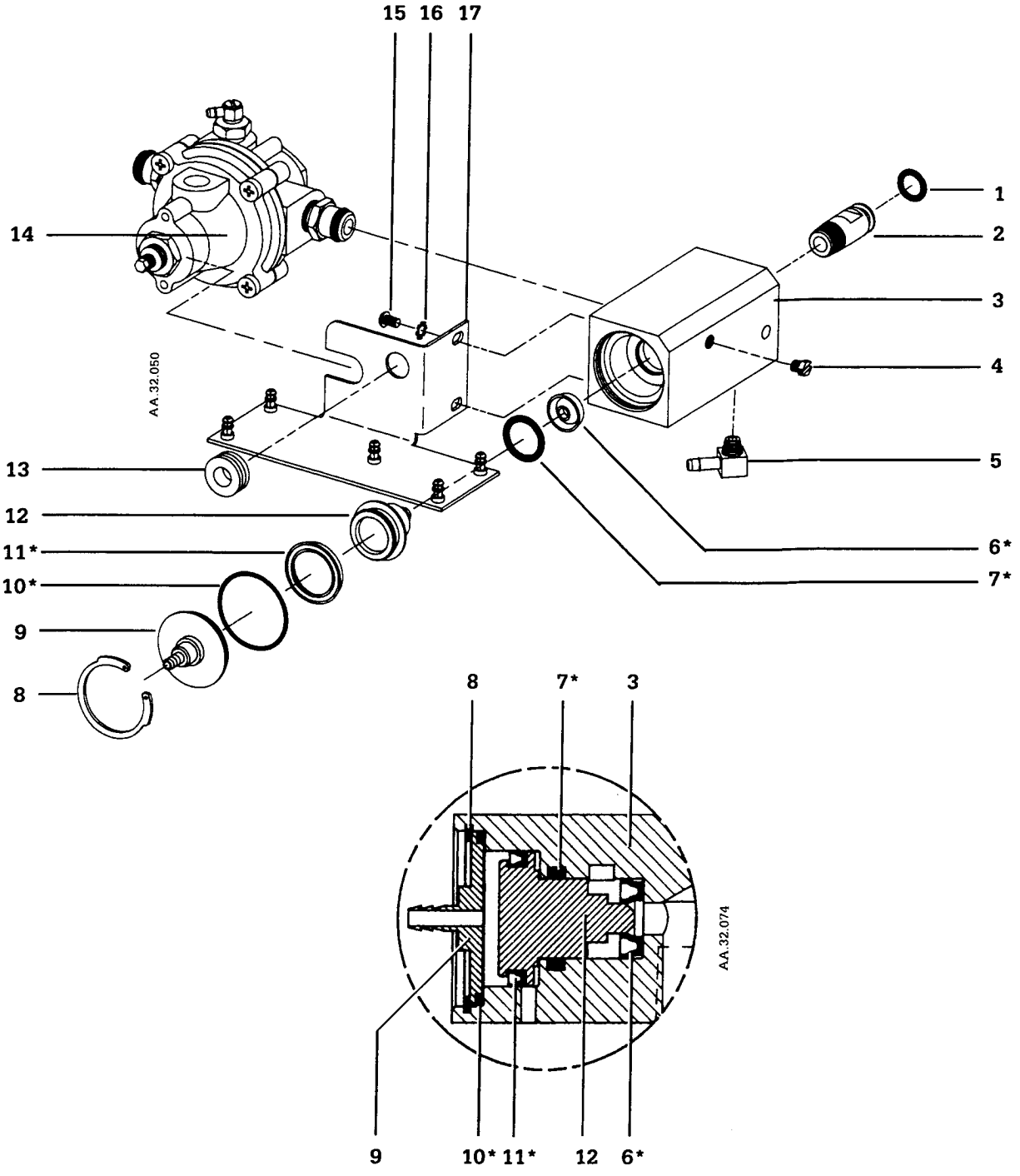


Figure 8-3 Primary Regulator and Gas Inlet Valve

Pneumatic Manifold

Exhalation Valve

Description	Stock Number	Quantity
1. Elbow Fitting, Adjustable, Barb	1500-3159-000	(4)
2. Retaining Ring, TRUARC, 34.9 mm housing	1500-3158-000	
3. Sleeve, Exhalation Valve	1500-5062-000	
4. Retainer, Exhalation Valve	1500-5006-000	
5. Diaphragm, Exhalation Valve	See Maintenance Kit	
6. 'O'-Ring, for Exhalation Valve Retainer and Sleeve	See Maintenance Kit	

Free Breathing Valve

Description	Stock Number
10. Seat, for Free Breathing Valve	0207-5590-100
11. Free Breathing Valve	See Maintenance Kit
12. 'O'-Ring, for Free Breathing Valve Seat	See Maintenance Kit

Other Pneumatic Manifold Parts

Description	Stock Number
8. 'O'-Ring, for Drive Gas Adapter	9221-3016-116
9. Drive Gas Adapter	1500-5005-000
13. 150 Mesh Screen	0214-7107-325
14. Legris Plug, 3/16 inch OD tubing	0213-4728-300

Pneumatic Manifold Assembly

Description	Stock Number
7. EEPROM and Pneumatic Manifold Assembly, to J7 (Header board), available only as matched pair	1500-8023-000

Yearly Ventilator Maintenance Kit—1500-8036-000—

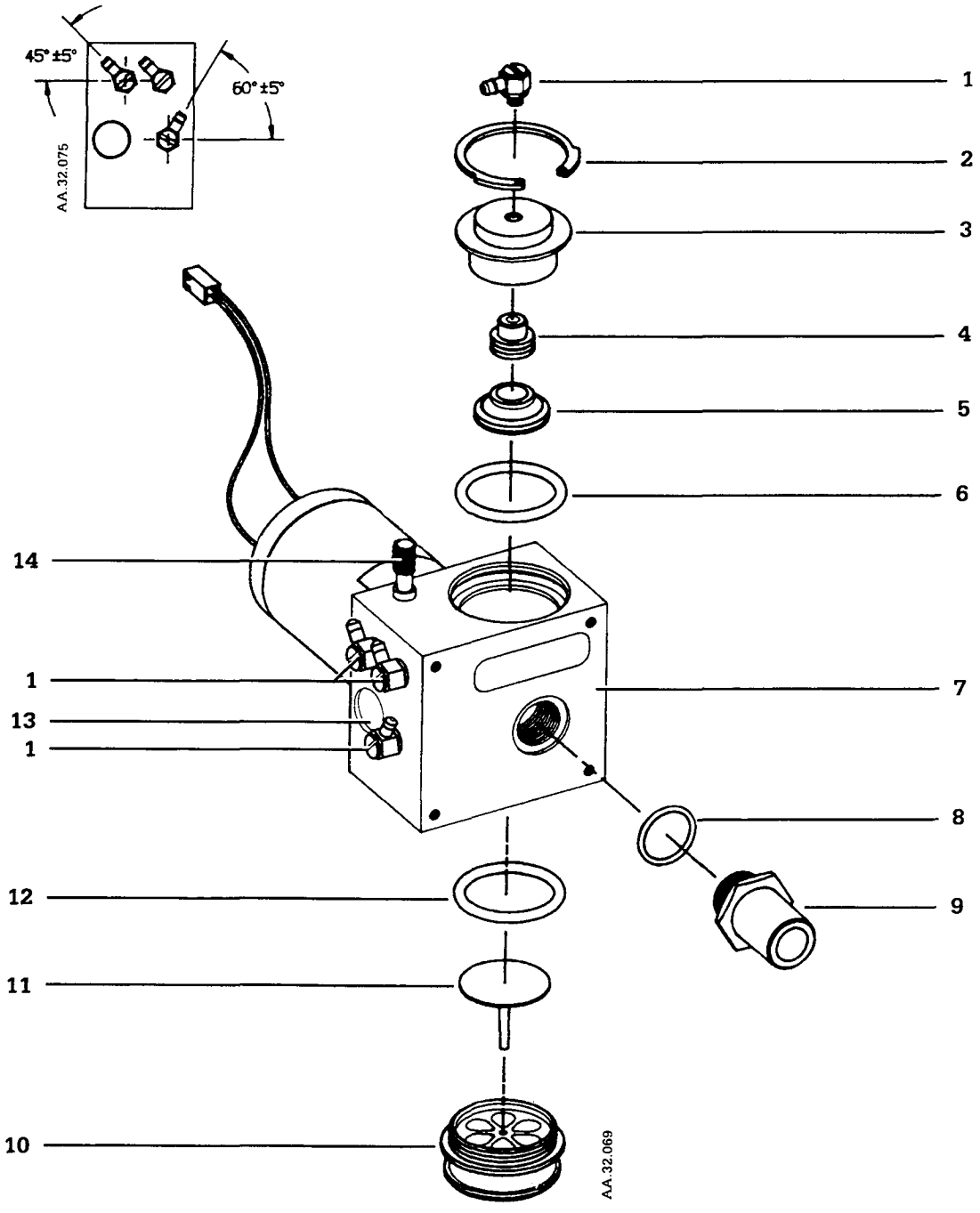


Figure 8-4 Pneumatic Manifold

Front Panel

	Description	Stock Number	Quantity
1.	Screw, M4 x 6, Button Head, stainless steel	9211-1040-067	(3)
2.	Washer, external lock, M4	9213-0540-003	(4)
3.	Front Panel Board	1500-8022-000	
4.	Washer, external lock, 1/4 inch	0202-3415-300	(2)
5.	Wheel, O_2 adjustment	1500-5015-000	
6.	Setscrew, M3 x 0.5, for O_2 wheel	9211-0830-053	
7.	Washer, shoulder	1500-3128-000	(3)
8.	Chassis Ground wire	1500-7037-000	
9.	Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
10.	Nut Torque, 1/4-32 x 7/16 inch, High Friction Fit, Do Not over tighten	1500-3129-000	(3)
11.	Switch Handle	1500-3409-000	
12.	Switch Guard, with 1/4-40 inch threads	0690-2500-344	
13.	Front Panel	1500-5036-000	
14.	Lens, Front Panel Window, use adhesive on lens to adhere	1500-3147-000	
15.	Switch, Momentary, red and yellow LEDs	1500-3089-000	
16.	Switch, Mechanical Ventilation	1500-3090-000	
17.	Switch, Momentary, green LED	1500-3055-000	

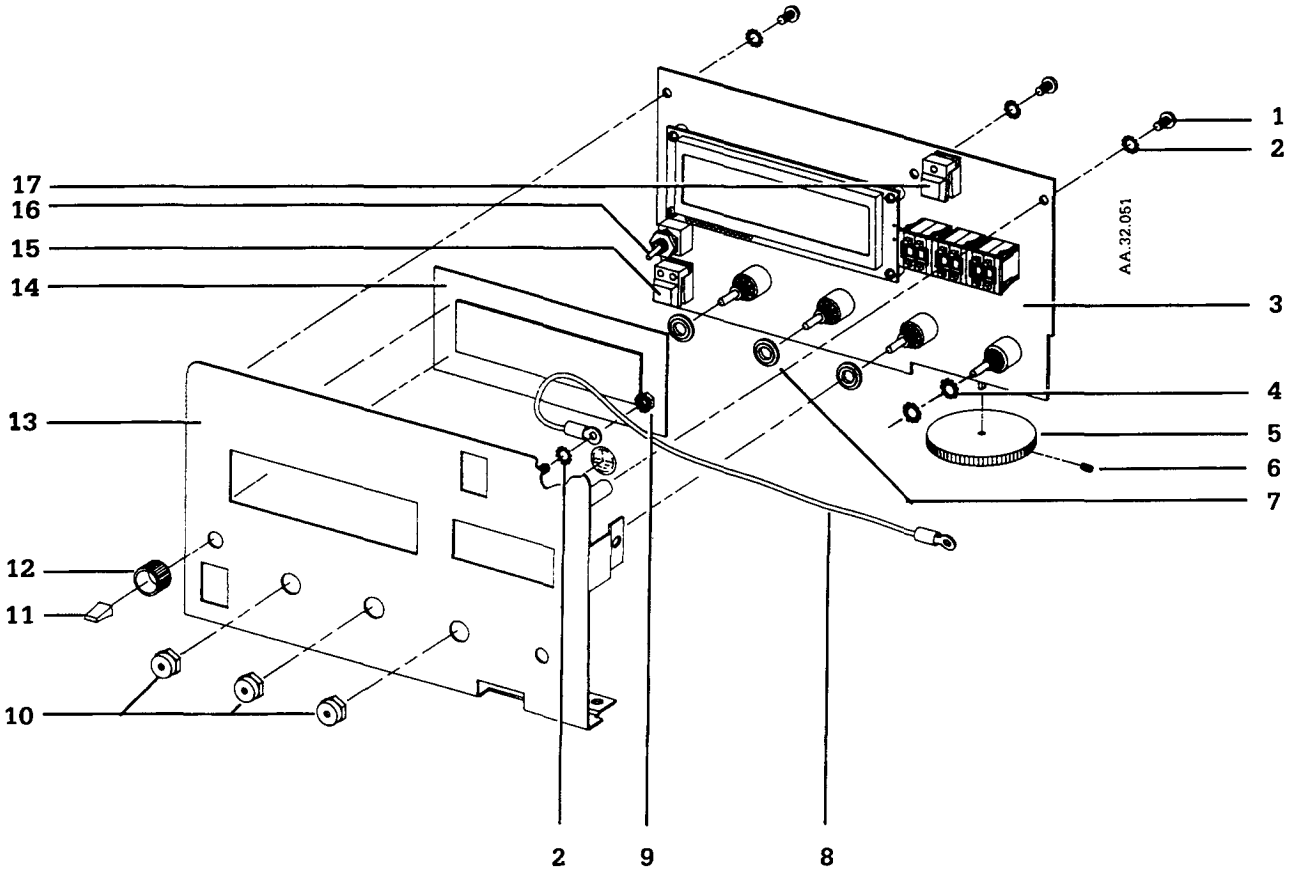
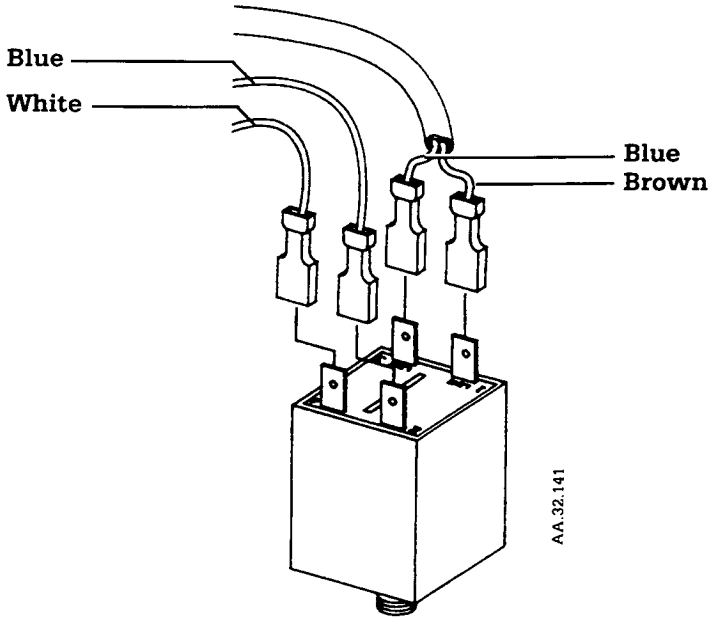


Figure 8-5 Front Panel

Transformer

Description	Stock Number	Quantity
1. Cable, AC power, filter to circuit breaker	1500-7051-000	
2. Circuit Breaker	1500-3182-000	
3. Nut, Keps, M3, stainless steel, with external lock washer	0144-3717-302	(2)
4. Box, Voltage selector	1500-5146-000	
5. Transformer Assembly, with switch	1500-7056-000	
6. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
7. Box, Transformer Assembly	1500-5025-000	
8. Washer, external lock, M4	9213-0540-003	(2)
. Screw, 6-32 x 1/4 inch, stainless steel, for transformer	0140-6524-105	(2)



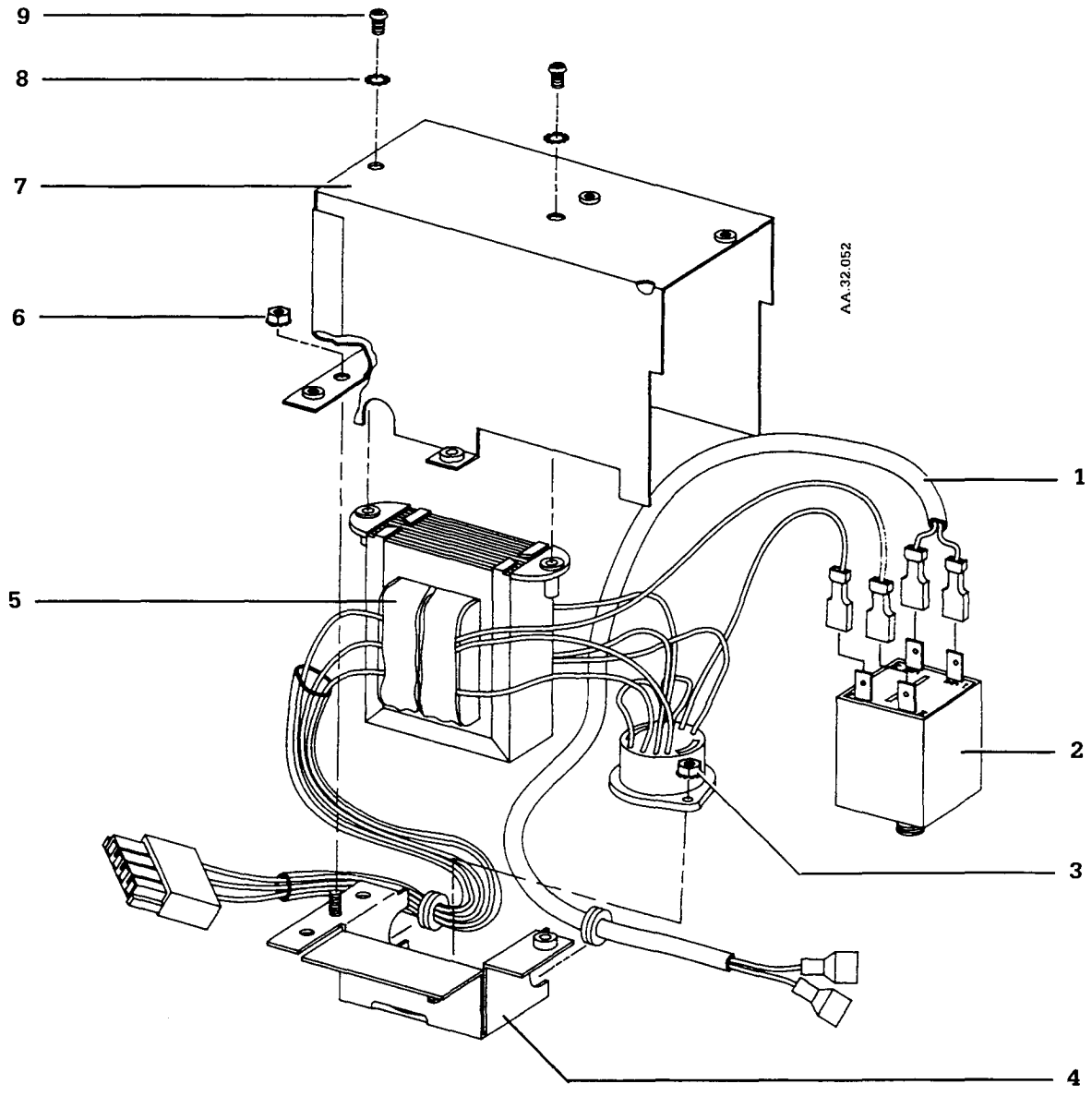


Figure 8-6 Transformer

Power Supply

Description	Stock Number	Quantity
1. Retainer, large nose, printed circuit board edge	1500-3150-000	(2)
2. Nut Speed, M4 X 0.7, U type	1500-3152-000	(4)
3. Chassis, Main	1500-5147-000	
4. Insulator, Power Supply Board	1500-3260-000	
5. Power Supply Board, includes box and guide	1500-7059-000	
6. Alignment Guide, Power Supply Board	1500-5041-000	
7. Adhesive Tape, double sided sticky	0220-5102-300	
8. Screw, M4 x 10, Button Head, stainless steel	9211-1040-109	(6)
9. Washer, external lock, M4	9213-0540-003	(6)
10. Box, Power Supply board	1500-5145-000	
11. Cable, J3 (Control Board) to J2 (Power Supply board)	1500-7057-000	
12. Nut, Keps, 6-32 inch, with external lock washer	0202-1130-300	(2)
13. Standoff, hinged for Control Board	1500-3148-000	(2)

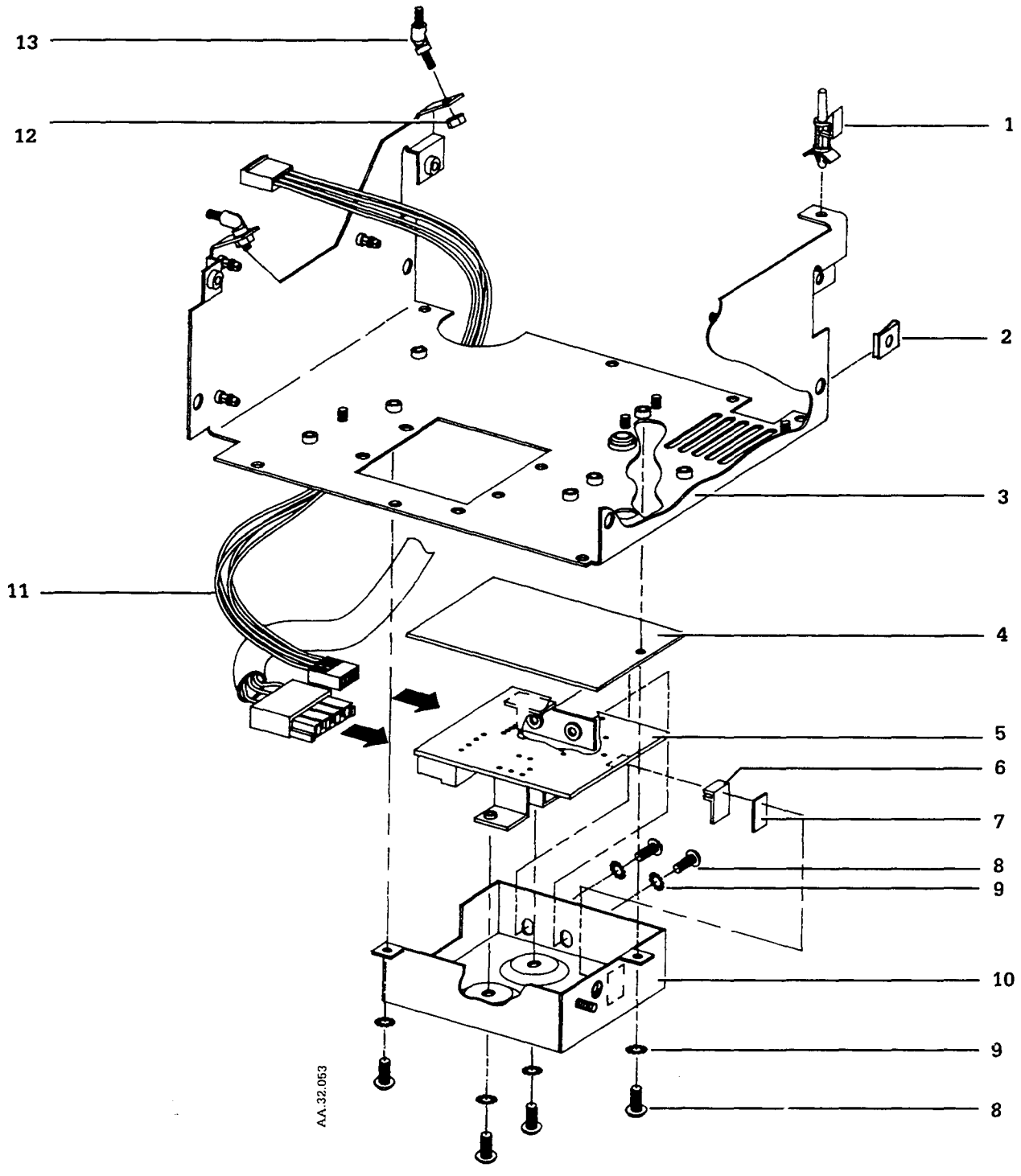


Figure 8-7 Power Supply

Transformer Mounting

Description	Stock Number	Quantity
1. Washer, external lock, M4	9213-0540-003	(4)
2. Screw. M4 x 10. Button Head. stainless steel	9211-1040-109	(4)

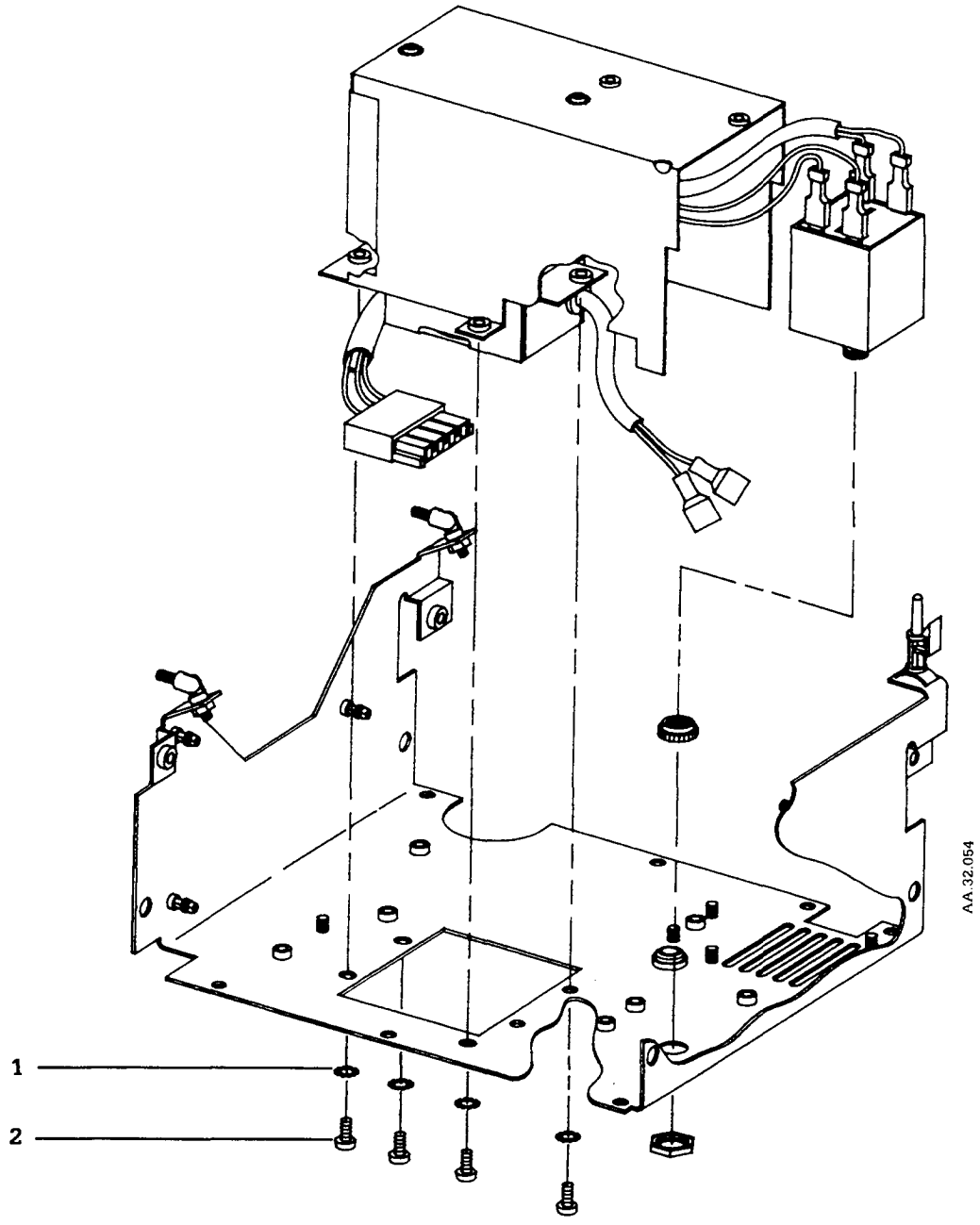


Figure 8-8 Transformer Mounting

Internal Pneumatic Enclosure

	Description	Stock Number	Quantity
1.	Cable tie, miniature	0203-5913-300	(4)
2.	Cable, J8 J9 J16 (Control Board) to J2 (Header board), includes nut	1500-3285-000	
3.	Cable, J6 (Control Board) to J1 (Pressure Transducer board), includes nut	1500-3286-000	
4.	Nut Keps, M4, stainless steel, external lock washer	0144-3717-314	(6)
5.	Enclosure, Inner Pneumatic	1500-3259-000	
6.	Cable, J7 (Control Board) to J1 (Header board), includes nut	1500-3284-000	
/.	Gasket Seal, for Inner Pneumatic Chamber	1500-3276-000	
8.	Rear Support Panel, for pneumatic chamber	1500-5098-000	
9.	Standoff, for pneumatic mounting panel	1500-5096-000	(4)

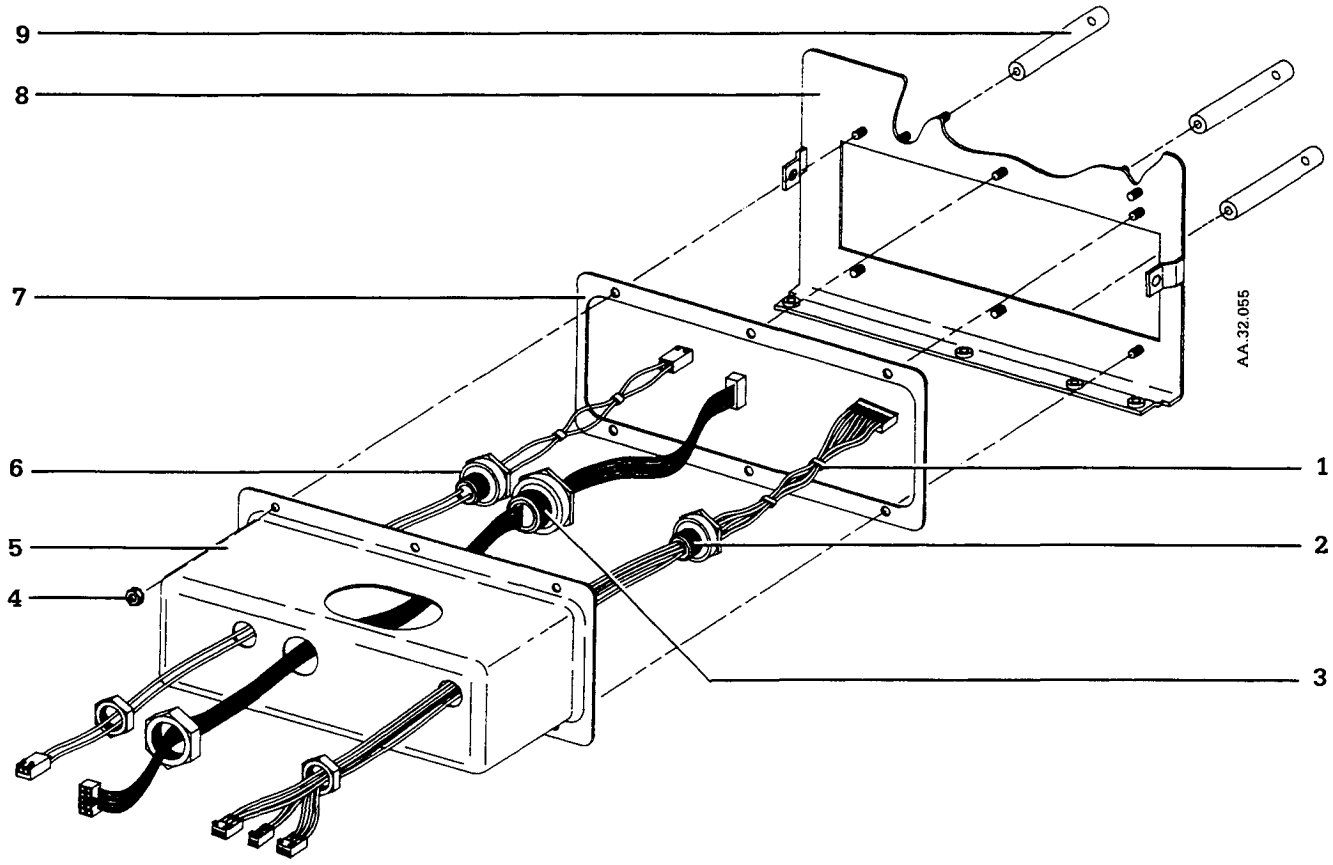


Figure 8-9 Internal Pneumatic Enclosure

Upper Control Module

Description	Stock Number	Quantity
1. Washer, external lock, M4	9213-0540-003	(8)
2. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	(4)
3. Screw, M4 x 6, Button Head, stainless steel	9211-1040-067	(2)
4. Chassis Ground wire	1500-7048-000	(2)
5. Speaker, with 9 inch leads	0208-1101-700	
6. Nut, Keps, M3, stainless steel, with external lock washer	0144-3717-302	(2)
7. Screw, M4 x 10, Button Head, stainless steel	9211-1040-109	(3)
8. Battery Pad	0999-1109-010	
9. Battery Clamp	1500-5094-000	
10. Chassis Ground wire	1500-7037-000	

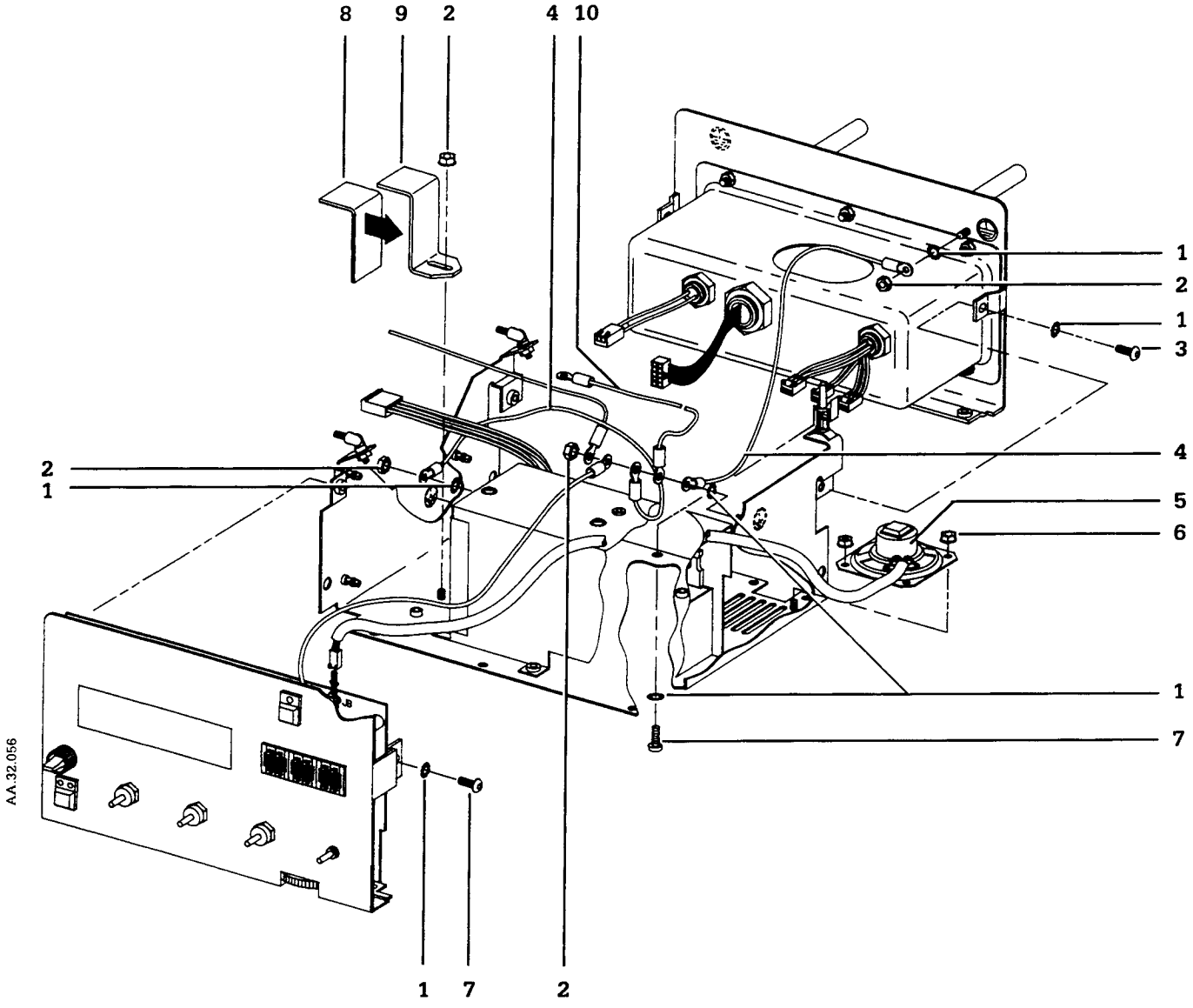


Figure 8-10 Upper Control Module

Lower Control Module

Description	Stock Number	Quantity
1. Screw, M4 x 10, Button Head	9211-1040-109	(5)
2. Washer, external lock, M4	9213-0540-003	(12)
3. Chassis Ground wire	1500-7049-000	(2)
4. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	(3)
5. Chassis Ground wire	1500-7048-000	(3)
6. Chassis Ground wire, spade lug	1500-7053-000	

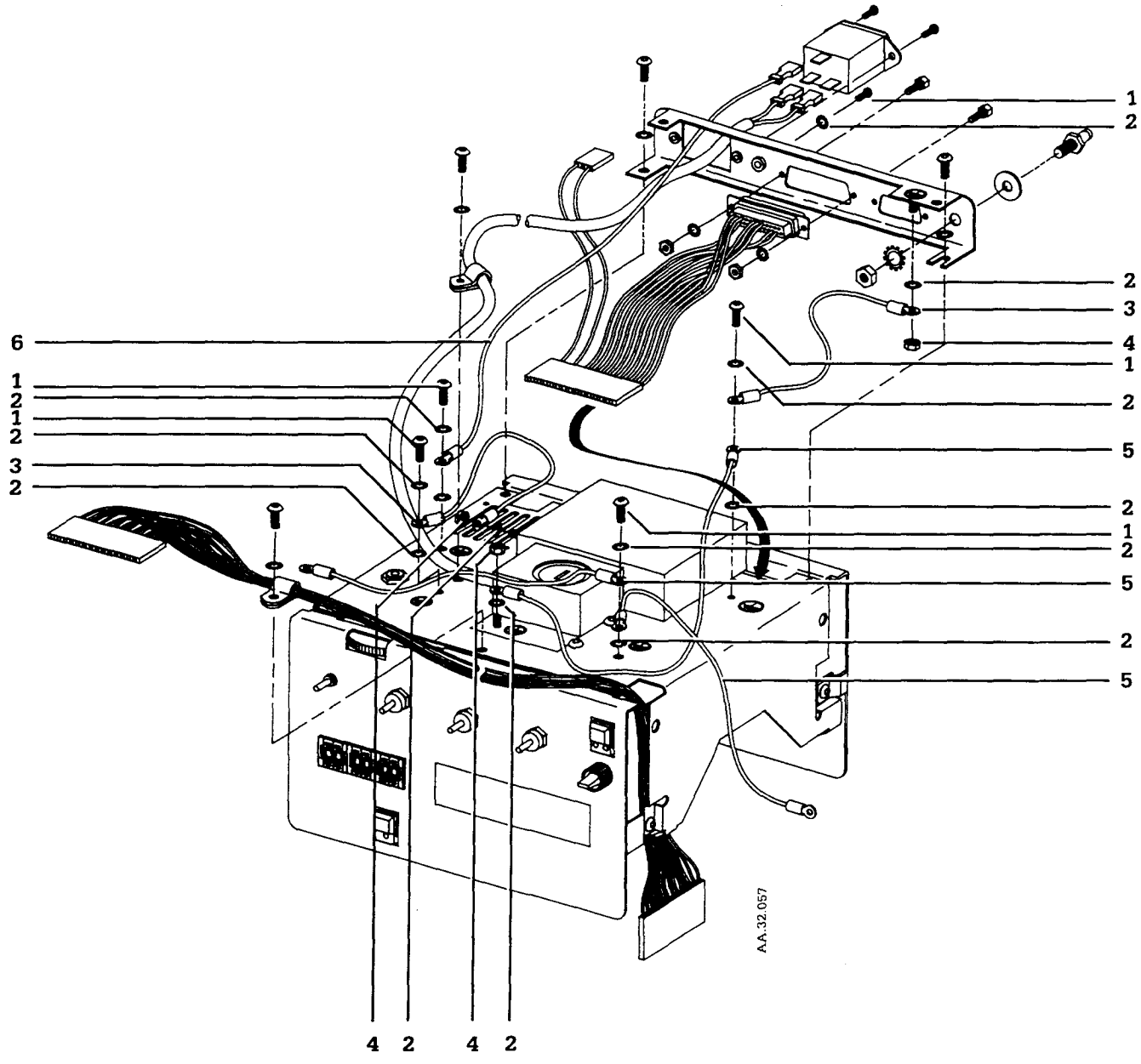
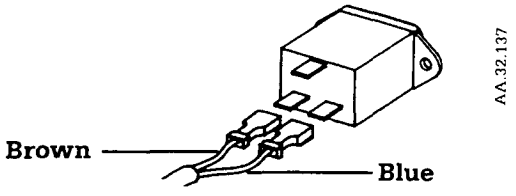


Figure 8-11 Lower Control Module

Lower Control Module Continued

Description	Stock Number	Quantity
1. Screw, M3 x 8, Pan, stainless steel	9211-0430-083	(2)
2. Screw, M4 x 10, Button Head	9211-1040-109	(4)
3. Washer, external lock, M4	9213-0540-003	(4)
4. Filter, AC inlet	1500-3273-000	
5. Jack Screw Set	0402-0250-300	
6. Equipotential Stud, Ground, Set	0208-0070-300	
7. Washer	0202-3223-300	(2)
8. Cable, J5 (Control Board) to Serial Interface and P1 (EMC/Interface board)	1500-7033-000	
9. Cable, J2 (Front Panel board) to P3 (EMC/Interface board)	1500-7031-000	
10. Cable Clamp	1500-3198-000	(2)
11. Cable, AC power, filter to circuit breaker	1500-7051-000	



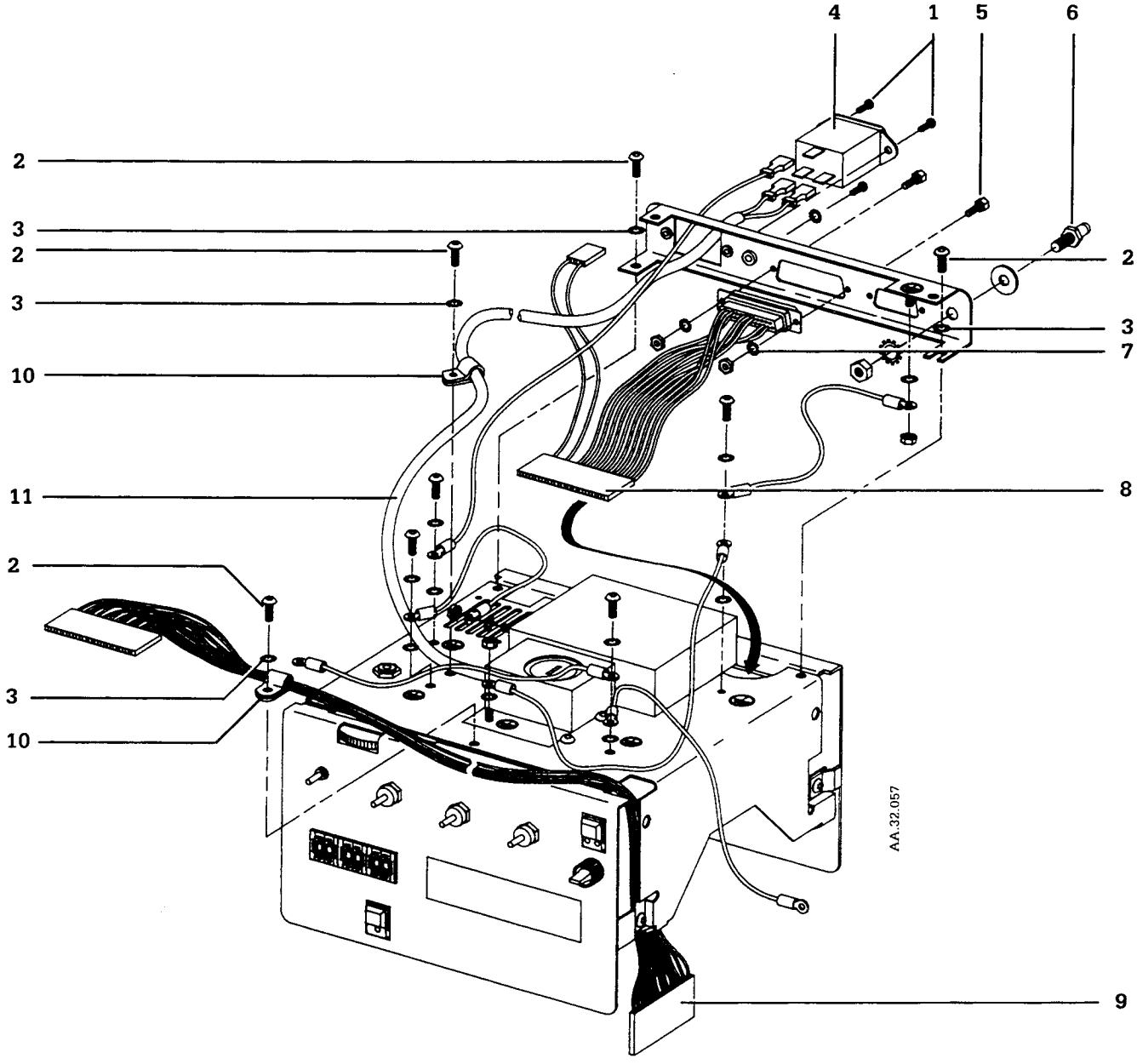


Figure 8-12 Lower Control Module Continued

Pneumatic Mounting Panel

Description	Stock Number	Quantity
1. Screw, 6 x 3/8 inch, for Secondary Regulator	0142-4163-107	(2)
2. Screw, M4 x 6, Button Head, stainless steel	9211-1040-067	(8)
3. Washer, external lock, M4	9213-0540-003	(5)
4. Header board	1500-3257-000	
5. EEPROM and Pneumatic Manifold Assembly, to J7 (Header board), available only as matched pair	1500-8023-000	
6. Secondary Regulator	1500-7072-000	
7. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
8. Gasket, for Pneumatic Manifold Assembly	1500-3149-000	
9. Chassis Ground wire	1500-7048-000	
10. Pneumatic Mounting Plate	1500-5100-000	
11. Distal Sensing Tee Connector	0229-0006-535	

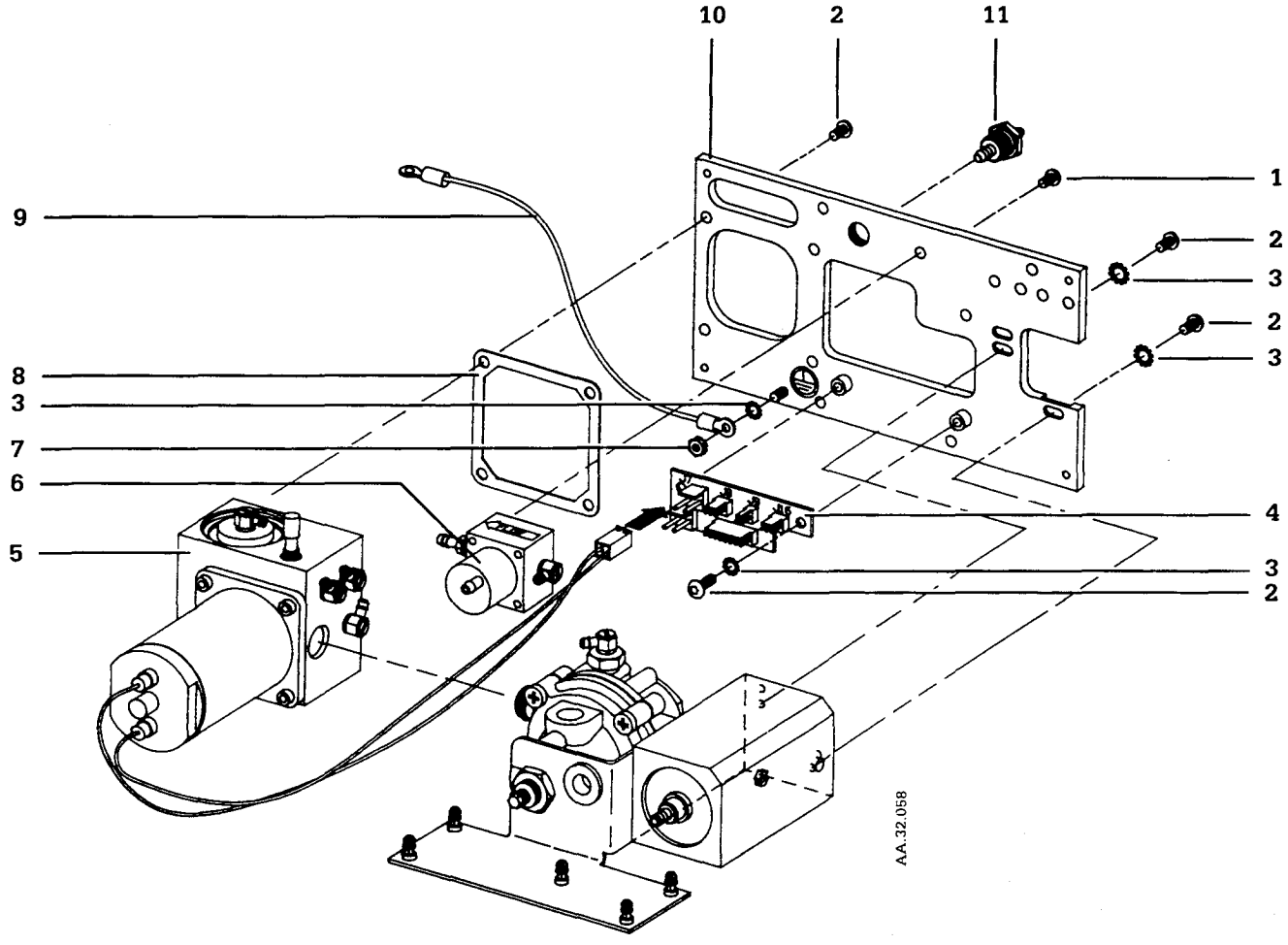


Figure 8-13 Pneumatic Mounting Panel

Solenoids and Pressure Transducer Board

Description	Stock Number	Quantity
1. High Pressure Limit Switch to J16 (Header board), includes adhesive tape	1500-3132-000	
2. Screw, 6-32 x 1/4 inch, stainless steel	0140-6524-105	(4)
3. Washer, external lock, M4	9213-0540-003	(4)
4. Spacer (must be used with solenoids)	0144-1010-131	(4)
5. Inlet Solenoid to J9 (Header board)	1500-7073-000	
6. Exhalation Solenoid to J8 (Header board)	1500-7074-000	
7. Cable Tie	0203-5913-300	
8. Pressure Transducer Board	1500-8024-000	

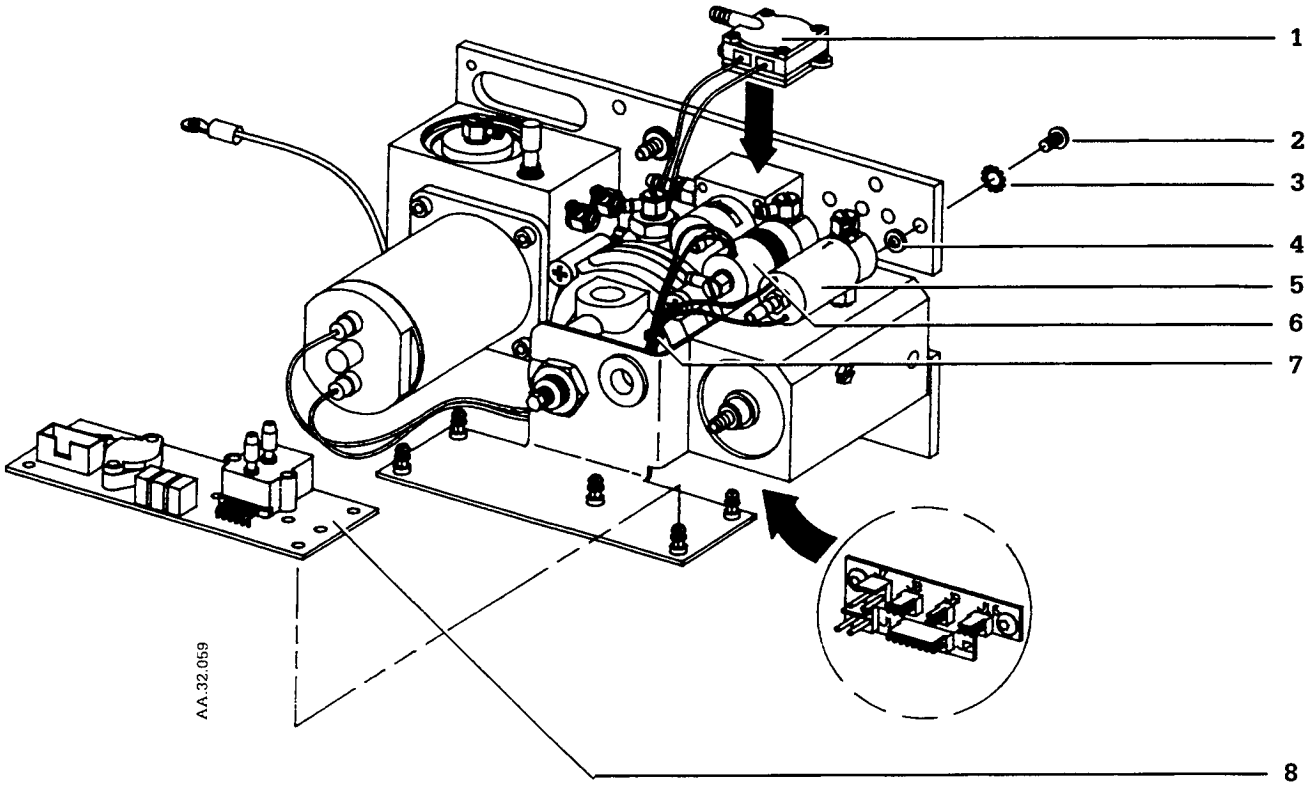


Figure 8-14 Solenoids and Pressure Transducer Board

Hoses TA1-TA5 and Tube TA6

Description	Stock Number
1. Filter Assembly (TA1, Filter, TA2)	1500-7062-000
2. Green High Pressure Hose, for TA1 - TA5	0994-6374-010
3. Clear Low Pressure Tubing, for TA6	0994-6370-010

Connection	Type	Length (mm)
TA1	Green Hose	120*
TA2	Green Hose	120*
TA3	Green Hose	200*
TA4	Green Hose	170*
TA5	Green Hose	155*
TA6	Clear Tubing	160*

Note: * All lengths in mm +/- 6 mm. When ordering, specify length in units of one foot (one foot equals 304.8 mm).

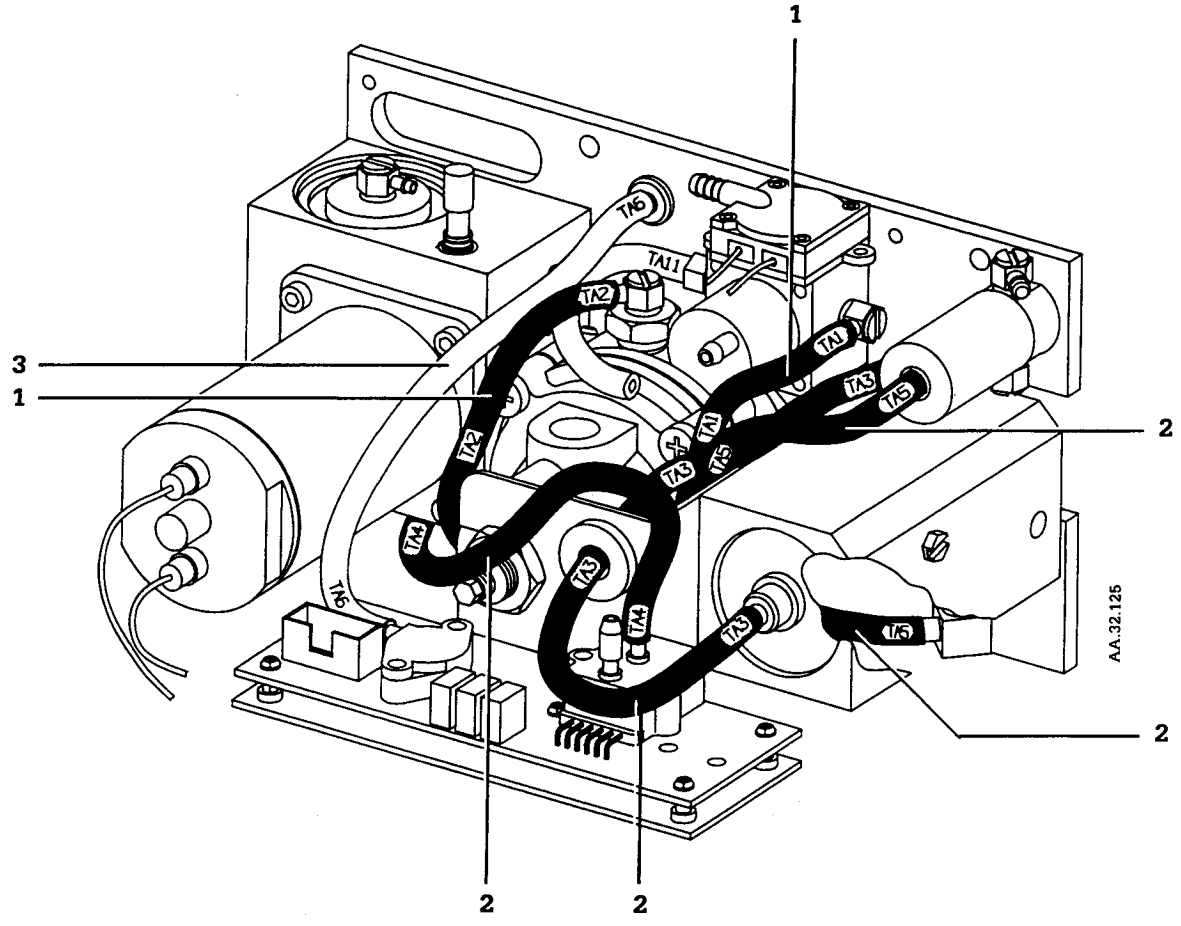


Figure 8-15 Hoses TA1 - TA5 and Tube TA6

Tubes TA7 - TA13

Description	Stock Number
1. Tee Brass, with 3 x 1/8 Inch Barbs	0204-8847-300
2. Clear Low Pressure Tubing, for TA7-TA13	0994-6370-010

Connection	Type	Length (mm)
TA7	Clear Tubing	160*
TA8	Clear Tubing	85*
TA9	Clear Tubing	50*
TA10	Clear Tubing	100*
TA11	Clear Tubing	180*
TA12	Clear Tubing	60*
TA13	Clear Tubing	120*

Note: * All lengths in mm +/- 6 mm. When ordering, specify length in units of one foot (one foot equals 304.8 mm).

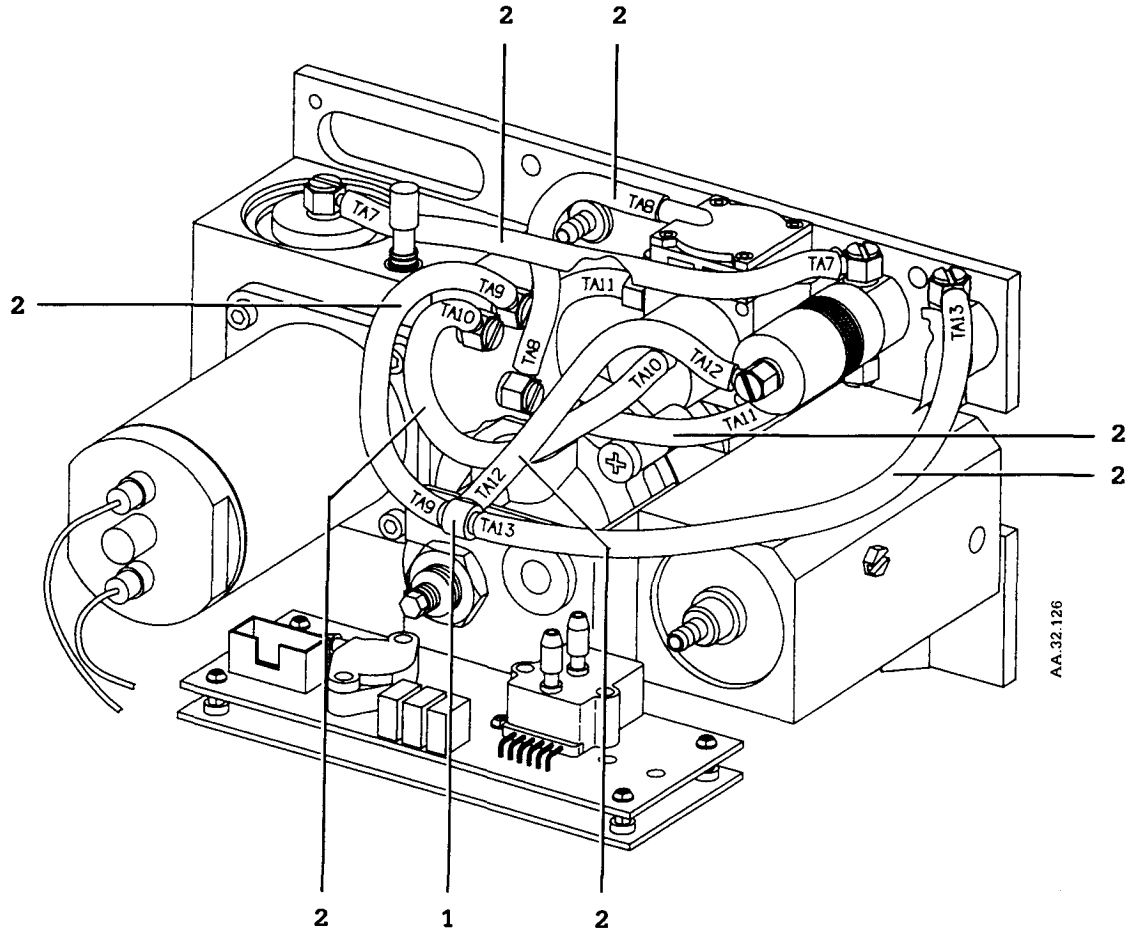


Figure 8-16 Tubes TA7-TA13

Pneumatic Chamber

Description	Stock Number	Quantity
1. Screw, M4 x 10, Button Head, stainless steel	9211-1040-109	(4)
2. Washer, external lock, M4	9213-0540-003	(5)
3. Cable, J8 J9 J16 (Control Board) to J2 (Header board), includes nut	1500-3285-000	
4. Gasket, Pneumatic Chamber	1500-3370-000	
5. Chassis Ground wire	1500-7048-000	(2)
6. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
7. Cable, J7 (Control Board) to J1 (Header board), includes nut	1500-3284-000	
8. Cable, J6 (Control Board) to J1 (Pressure Transducer board), includes nut	1500-3286-000	

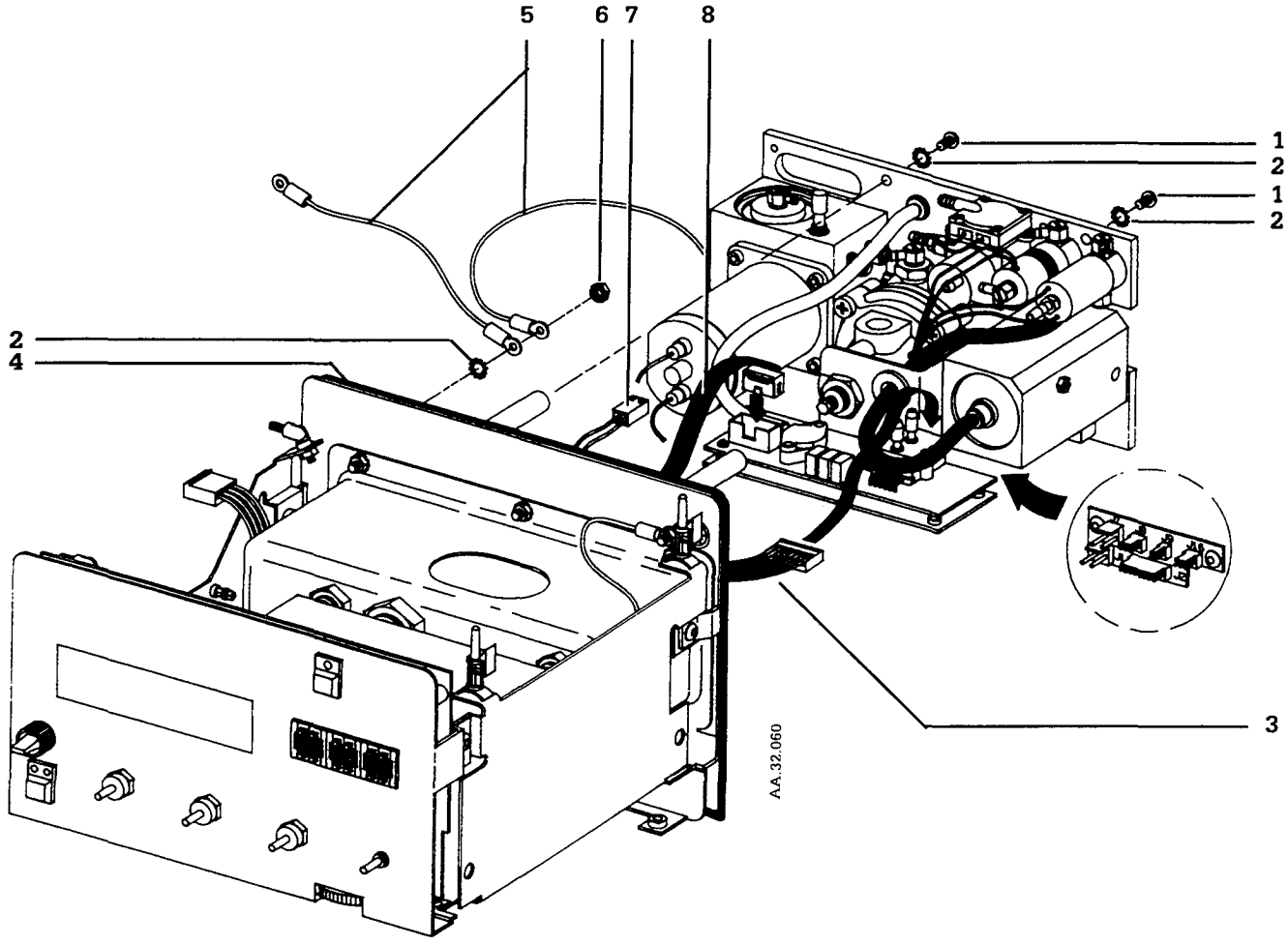


Figure 8-17 Pneumatic Chamber

Control Board and Cables

Description	Stock Number	Quantity
1. Cable, J6 (Control Board) to J1 (Pressure Transducer board), includes nut	1500-3286-000	
2. Cable, J5 (Control Board) to Serial Interface and P1 (EMC/Interface board)	1500-7033-000	
3. Cable, J8 J9 J16 (Control Board) to J2 (Header board), includes nut	1500-3285-000	
4. Cable Tie	0203-5913-300	(2)
5. Cable, J1 (Control Board) to J1 (Front Panel board)	1500-7020-000	
6. Cable, J2 (Front Panel board) to P3 (EMC/ Interface board)	1500-7031-000	
7. Cable, J7 (Control Board) to J1 (Header board), includes nut	1500-3284-000	
8. Cable, J3 (Control Board) to J2 (Power Supply board)	1500-7057-000	
9. Nut, Keps, 6-32 inch, with external lock washer	0202-1130-300	(2)
10. Fuse, 4 Amp, 125 V ac minimum, Time-Delay, 5 x 20 mm	1500-3402-000	(2)
11. Jumper, mini, 2-position J11	0686-1500-300	
12. 64K Multilayer Control Board, (does not include EPROM, or EEPROM)	1500-8027-000	

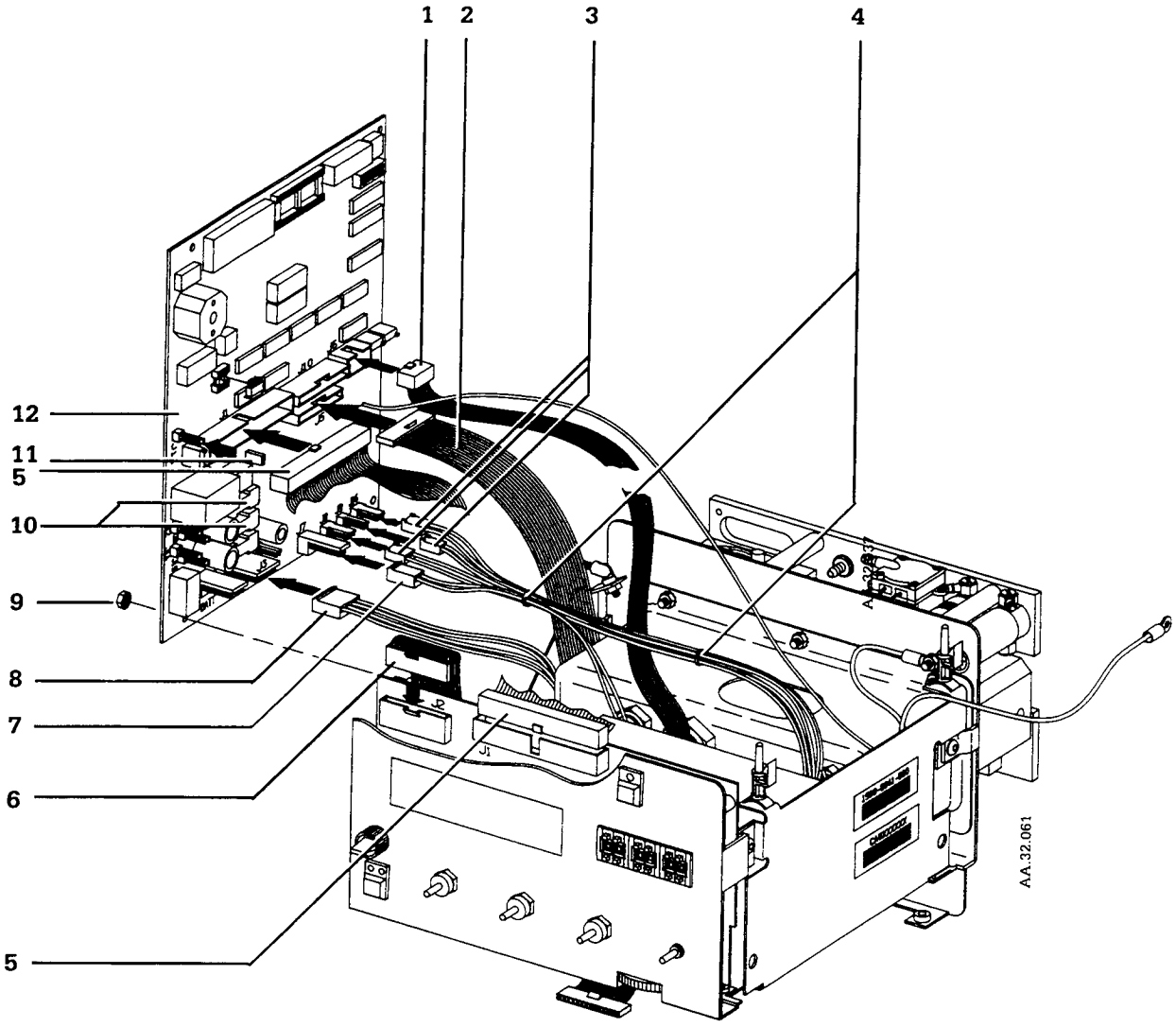


Figure 8-18 Control Board and Cables

EMC/Interface Board, Stand-Alone

Description	Stock Number	Quantity
1. Switch and Cable, to P4 (EMC/Interface board) ON/Standby	1500-7032-000	
2. Indicator, Mains	1500-3335-000	
3. Cable, J2 (Front Panel board) to P3 (EMC/ Interface board)	1500-7031-000	
4. Cable, J5 (Control Board) to Serial Interface and P1 (EMC/Interface board)	1500-7033-000	
5. Chassis Ground wire	1500-7048-000	(2)
6. Screw, M4 x 6, Button Head, stainless steel	9211-1040-067	(3)
Washer, external lock, M4	9213-0540-003	(6)
8. EMC/Interface Board	1500-3315-000	
9. Nuts, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
10. Lower Front Panel, Stand Alone	1500-5148-000	
11. Screws, M4 x 10, Button Head, Stainless steel	9211-1040-109	(2)

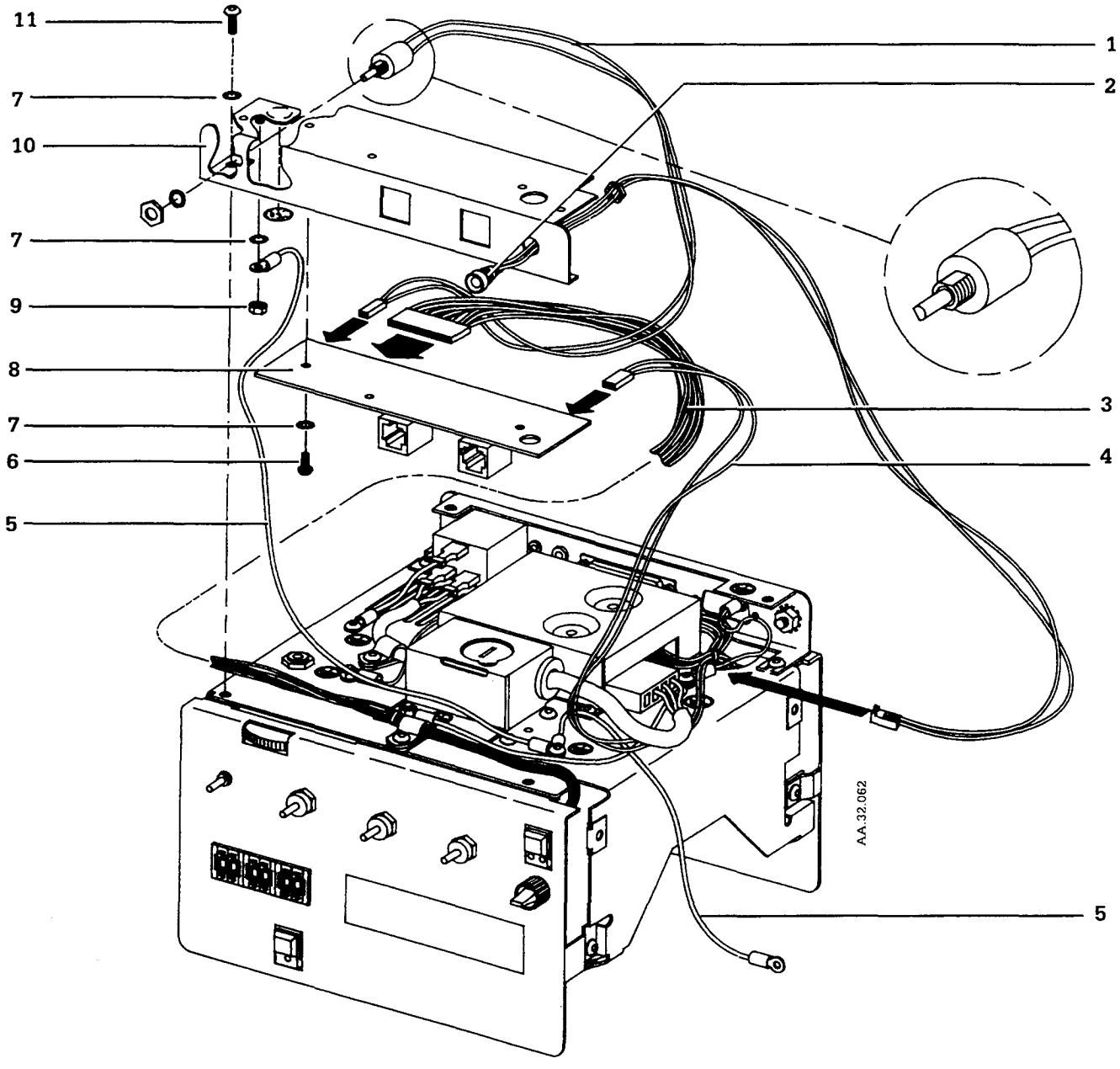


Figure 8-19 EMC/Interface Board, Stand-Alone

EMC/Interface Board, Excel Mount

Description	Stock Number	Quantity
1. Indicator, Mains	1500-3335-000	
2. Cable, J2 (Front Panel board) to P3 (EMC/ Interface board)	1500-7031-000	
3. Cable, J5 (Control Board) to Serial Interface and P1 (EMC/Interface board)	1500-7033-000	
4. Cable, Sensor/Remote to P2 (EMC/Interface board)	1500-7036-000	
5. Spacer, Jackpost, Hex 4-40 inch, set	0402-0250-300	
6. Washer, external lock	0202-3223-300	(2)
7. Chassis Ground wire	1500-7048-000	(2)
8. Screw, M4 x 6, Button Head, stainless steel	9211-1040-067	(3)
9. Washer, external lock, M4	9213-0540-003	(6)
10. EMC/Interface Board	1500-3315-000	
11. Nuts, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
12. Lower Front Panel, Excel Mount	1500-5143-000	
13. Screws, M4 x 10, Button Head, stainless steel	9211-1040-109	(2)

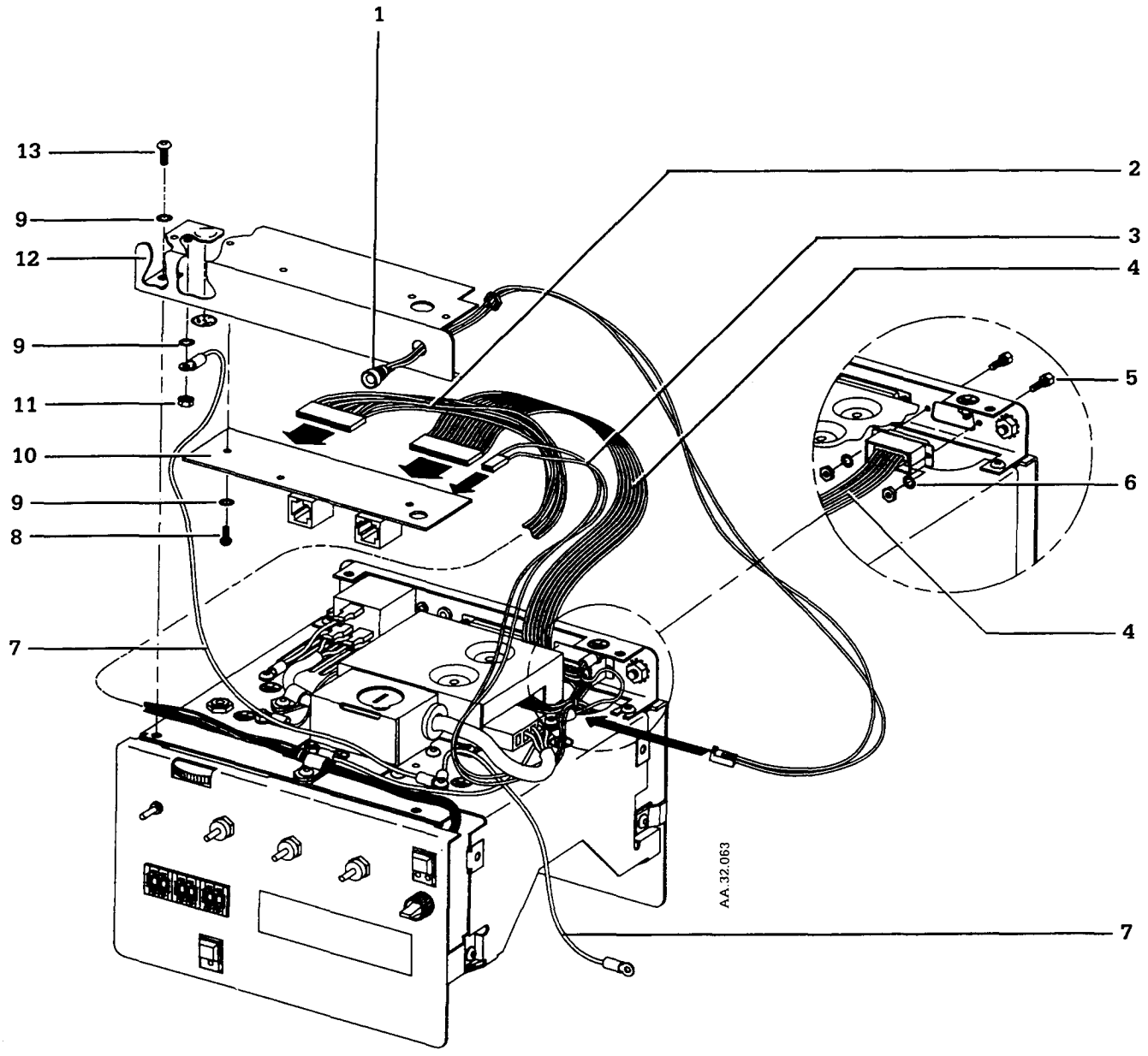


Figure 8-20 EMC/Interface Board, Excel Mount

Bottom Shroud, Stand Alone

Description	Stock Number	Quantity
1. 64K EPROM kit, English version 4.20	1500-8020-000	
64K EPROM kit, French version 4.20	1500-8053-000	
64K EPROM kit, German version 4.20	1500-8054-000	
64K EPROM kit, Italian version 4.20	1500-8055-000	
64K EPROM kit, Swedish version 4.20	1500-8056-000	
64K EPROM kit, Spanish version 4.20	1500-8057-000	
2. Seal, Access Port	1500-3278-000	
3. Sleeve, Preoperative Check List	1500-3233-000	
4. Nut, Acorn M4, stainless steel	0144-3127-100	(2)
5. Shroud, Lower 78xx Ventilator	1500-5029-000	
Washer, external lock, M4	9213-0540-003	(5)
7. Screw, M4 x 16, Pan Head Type 316, stainless steel,	9211-0440-163	(8)
8. Label Set; English; Part C, E	1500-3281-000	
Label Set; French; Part C, E	1500-3247-000	
Label Set; German; Part C, E	1500-3229-000	
Label Set; Italian; Part C, E	1500-3261-000	
Label Set; Swedish; Part C, E	1500-3230-000	
Label Set; Spanish; Part C, E	1500-3254-000	
9. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
10. Bumper, Recessed, 0.688 inch Diameter Rubber, for number 8 screw	0411-1959-100	(4)
11. Retainer, push-on, 3.6 mm ID, 12.7 mm OD, Black Plastic	1001-3845-000	(2)
12. Card, Preoperative Check List, English	1500-3194-000	
Card, Preoperative Check List, French	1500-3238-000	
Card, Preoperative Check List, German	1500-3239-000	
Card, Preoperative Check List, Italian	1500-3241-000	
Card, Preoperative Check List, Swedish	1500-3237-000	
Card, Preoperative Check List, Spanish	1500-3240-000	
13. Knob, ON/Standby, Black, 0.125 inch Shaft	1500-3190-000	
14. Battery Pack, with harness, Ni-Cd, 4.8 V dc 1.3 Amp hour	1500-3125-000	

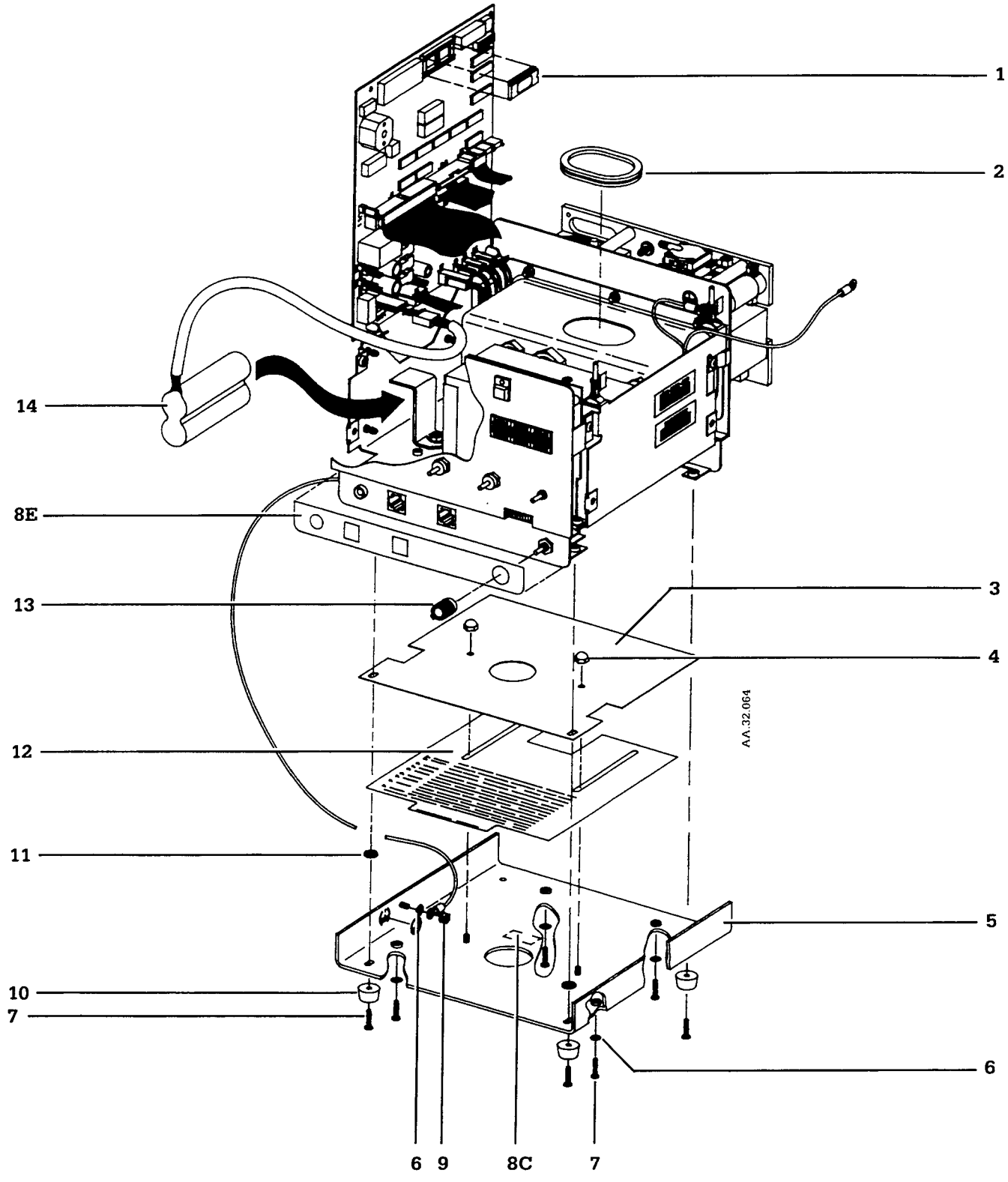


Figure 8-21 Bottom Shroud, Stand Alone

Bottom Shroud, Excel Mount

Description	Stock Number	Quantity
1. 64K EPROM kit, English version 4.20	1500-8020-000	
64K EPROM kit, French version 4.20	1500-8053-000	
64K EPROM kit, German version 4.20	1500-8054-000	
64K EPROM kit, Italian version 4.20	1500-8055-000	
64K EPROM kit, Swedish version 4.20	1500-8056-000	
64K EPROM kit, Spanish version 4.20	1500-8057-000	
2. Seal, Access Port	1500-3278-000	
3. Sleeve, Preoperative Check List	1500-3233-000	
4. Nut, Acorn M4, stainless steel	0144-3127-100	(2)
5. Shroud, Lower 78xx Ventilator	1500-5029-000	
6. Washer, external lock, M4	9213-0540-003	(5)
7. Screw, M4 x 16, Pan Head Type 316, stainless steel,	9211-0440-163	(8)
8. Label Set; English; Part C, J	1500-3281-000	
Label Set; French; Part C, J	1500-3247-000	
Label Set; German; Part C, J	1500-3229-000	
Label Set; Italian; Part C, J	1500-3261-000	
Label Set; Swedish; Part C, J	1500-3230-000	
Label Set; Spanish; Part C, J	1500-3254-000	
9. Nut, Keps, M4, stainless steel, with external lock washer	0144-3717-314	
10. Bumper, Recessed, 0.688 inch Diameter Rubber, for number 8 screw	0411-1959-100	(4)
11. Retainer, push-on, 3.6 mm ID, 12.7 mm OD, Black Plastic	1001-3845-000	(2)
12. Card, Preoperative Check List, English	1500-3194-000	
Card, Preoperative Check List, French	1500-3238-000	
Card, Preoperative Check List, German	1500-3239-000	
Card, Preoperative Check List, Italian	1500-3241-000	
Card, Preoperative Check List, Swedish	1500-3237-000	
Card, Preoperative Check List, Spanish	1500-3240-000	
13. Battery Pack, with harness, Ni-Cd, 4.8 V dc 1.3 Amp hour	1500-3125-000	

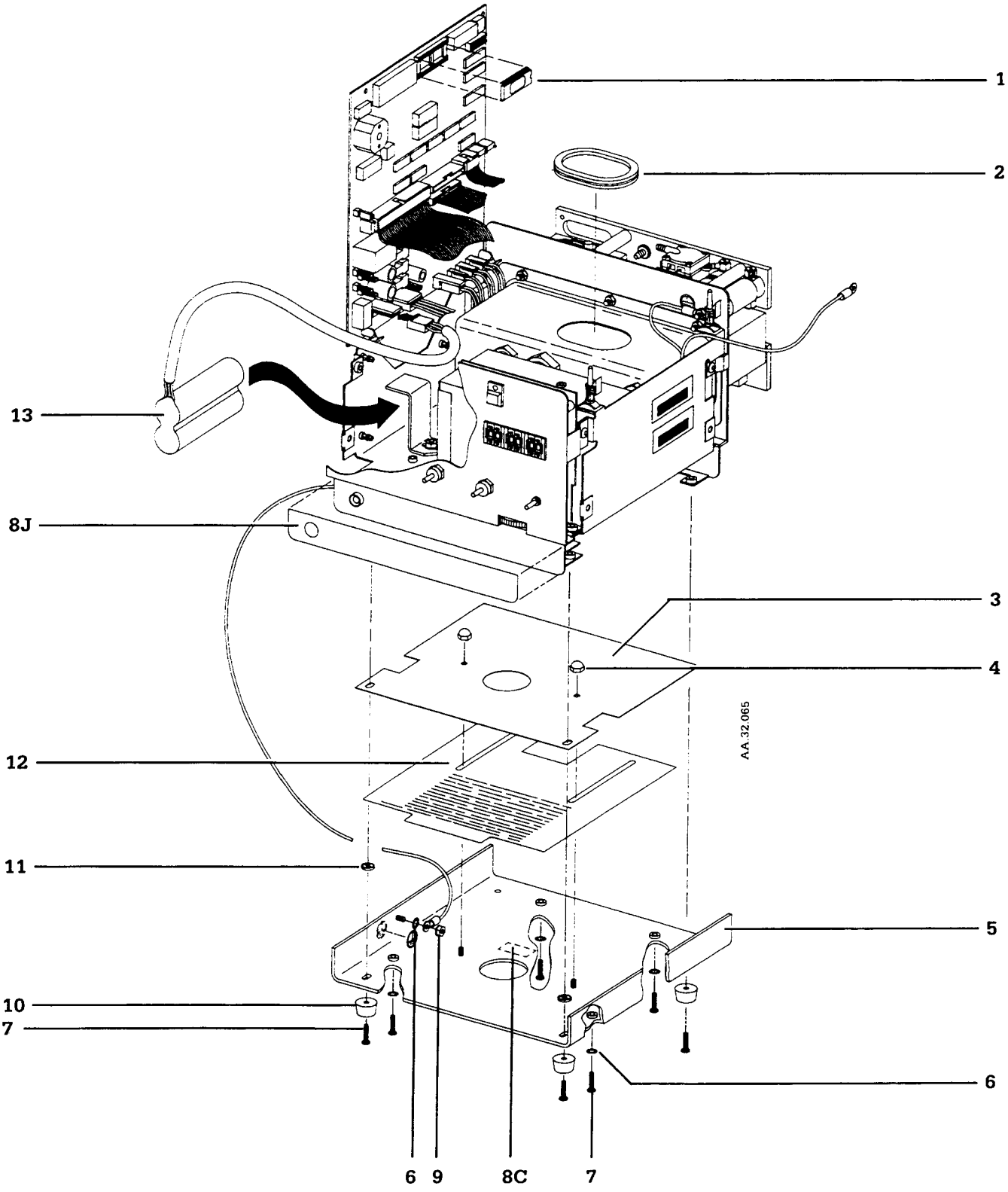


Figure 8-22 Bottom Shroud, Excel Mount

Pneumatic Cover, Stand Alone

	Description	Stock Number	Quantity
1.	Label Set; English; Part A, D	1500-3281-000	
	Label Set; French; Part A, D	1500-3247-000	
	Label Set; German; Part A, D	1500-3229-000	
	Label Set; Italian; Part A, D	1500-3261-000	
	Label Set; Swedish; Part A, D	1500-3230-000	
	Label Set; Spanish; Part A, D	1500-3254-000	
2.	Clamp, Power Cord	1500-3274-000	
3.	Power Cord, English	1500-3283-000	
	Power Cord; German, Swedish, Spanish, French	1500-3291-000	
	Power Cord, Italian	1500-3293-000	
	Power Cord, Swiss	1500-3292-000	
4.	Nut, Keps, M4, stainless steel	0144-3717-314	
	Washer, external lock, M4	9213-0540-003	(7)
6.	Screw, M4 x 10, Button Head, stainless steel	9211-1040-109	(4)
7.	Seal, Bonded M18, O_2	9224-0618-232	
	Seal, Bonded M16, Air	9224-0616-229	
8.	Fitting; O_2 NIST; English, French, Italian, Spanish	1001-5967-000	
	Fitting, Air DIN, German	1202-5198-000	
	Fitting, Air SPRI, Swedish	1001-5854-000	
	Fitting, O_2 DIN, optional	1202-5196-000	
	Fitting, Air NIST, optional	1001-5826-000	
9.	Screw, Inlet Block, M4 x 30, Cap Head	9211-0640-304	(2)
10.	Label, Gas Supply, O_2, English	1500-3231-000	
	Label, Gas Supply, O_2, French	1500-3244-000	
	Label, Gas Supply, O_2, German	1500-3408-000	
	Label, Gas Supply, O_2, Italian	1500-3258-000	
	Label, Gas Supply, O_2, Swedish	none	
	Label, Gas Supply, O_2, Spanish	1500-3251-000	
	Label, Gas Supply, Air, English	1500-3232-000	
	Label, Gas Supply, Air, French	1500-3248-000	
	Label, Gas Supply, Air, German	1500-3223-000	
	Label, Gas Supply, Air, Italian	1500-3262-000	
	Label, Gas Supply, Air, Swedish	1500-3236-000	
	Label, Gas Supply, Air, Spanish	1500-3255-000	
11.	Inlet Block, O2	1500-5102-000	
	Inlet Block, Air	1500-5103-000	
12.	Pneumatic Cover, Black, Rear, 7800	1500-5101-000	
13.	Gasket, Pneumatics Seal, 7800	1500-3277-000	

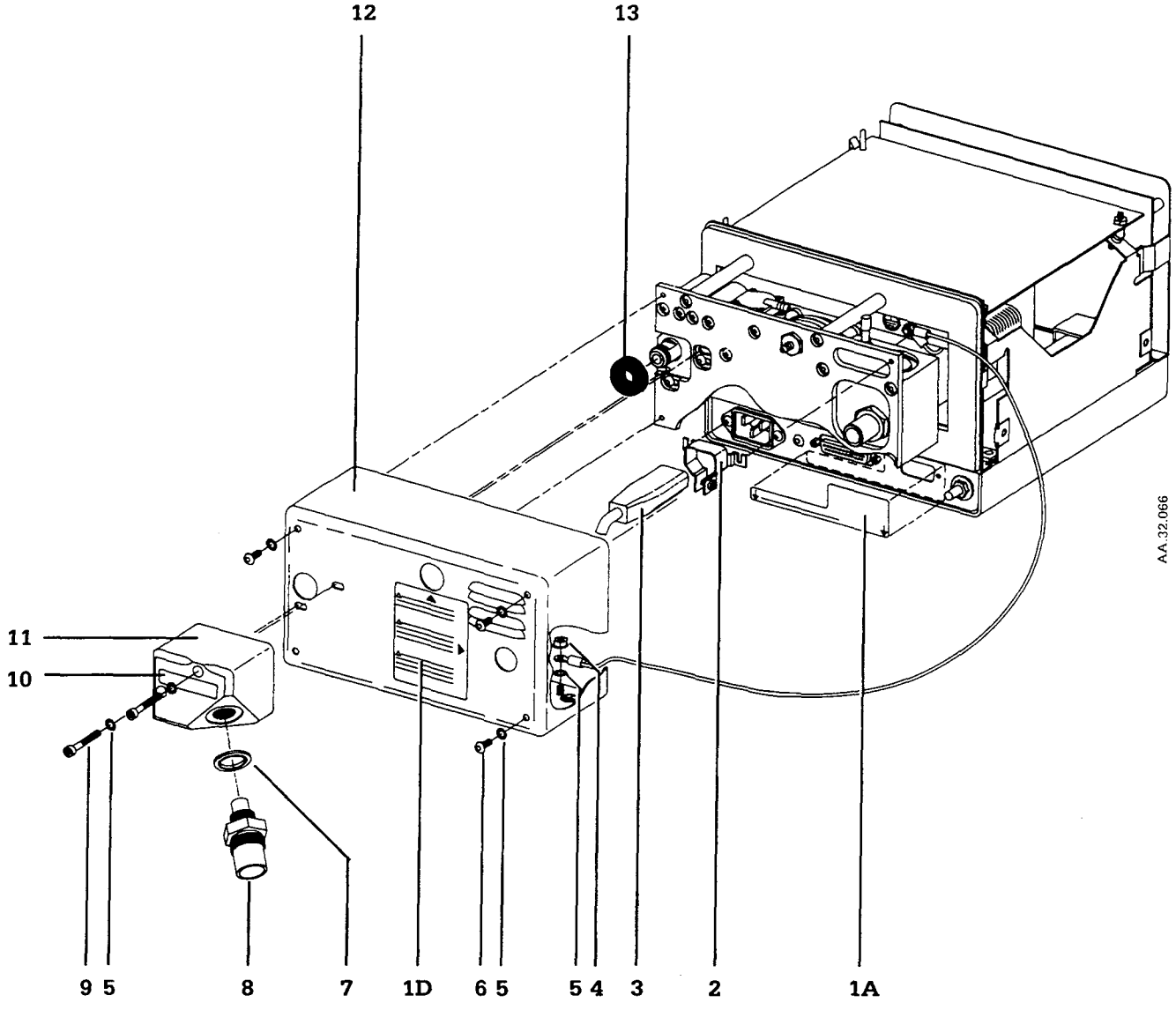


Figure 8-23 Pneumatic Cover, Stand Alone

Pneumatic Cover, Excel Mount

Description	Stock Number	Quantity
1. Label Set; English; Part B, D	1500-3281-000	
Label Set; French; Part B, D	1500-3247-000	
Label Set; German; Part B, D	1500-3229-000	
Label Set; Italian; Part B, D	1500-3261-000	
Label Set; Swedish; Part B, D	1500-3230-000	
Label Set; Spanish; Part B, D	1500-3254-000	
2. Clamp, Power Cord	1500-3274-000	
3. Power Cord, French, English	1500-7050-000	
Power Cord; German, Swedish, Spanish	1500-3291-000	
Power Cord, Italian	1500-3293-000	
Power Cord, Swiss	1500-3292-000	
4. Nut, Keps, M4, stainless steel	0144-3717-314	
5. Washer, external lock, M4	9213-0540-003	(7)
6. Screw, M4 x 10, Button Head, stainless steel	9211-1040-109	(4)
7. Seal, Bonded M18, O_2	9224-0618-232	
Seal, Bonded M16, Air	9224-0616-229	
8. Fitting; O_2 NIST; English, French, Italian, Spanish	1001-5967-000	
Fitting, Air DIN, German	1202-5198-000	
Fitting, Air SPRI, Swedish	1001-5854-000	
Fitting, O_2 DIN, optional	1202-5196-000	
Fitting, Air NIST, optional	1001-5826-000	
9. Screw, Inlet Block, M4 x 30, Cap Head	9211-0640-304	(2)
10. Label, Gas Supply, O_2, English	1500-3231-000	
Label, Gas Supply, O_2, French	1500-3244-000	
Label, Gas Supply, O_2, German	1500-3408-000	
Label, Gas Supply, O_2, Italian	1500-3258-000	
Label, Gas Supply, O_2, Swedish	none	
Label, Gas Supply, O_2, Spanish	1500-3251-000	
Label, Gas Supply, Air, English	1500-3232-000	
Label, Gas Supply, Air, French	1500-3248-000	
Label, Gas Supply, Air, German	1500-3223-000	
Label, Gas Supply, Air, Italian	1500-3262-000	
Label, Gas Supply, Air, Swedish	1500-3236-000	
Label, Gas Supply, Air, Spanish	1500-3255-000	
11. Inlet Block, O2	1500-5102-000	
Inlet Block, Air	1500-5103-000	
12. Pneumatic Cover, Black, Rear, 7800	1500-5101-000	
13. Gasket, Pneumatics Seal, 7800	1500-3277-000	

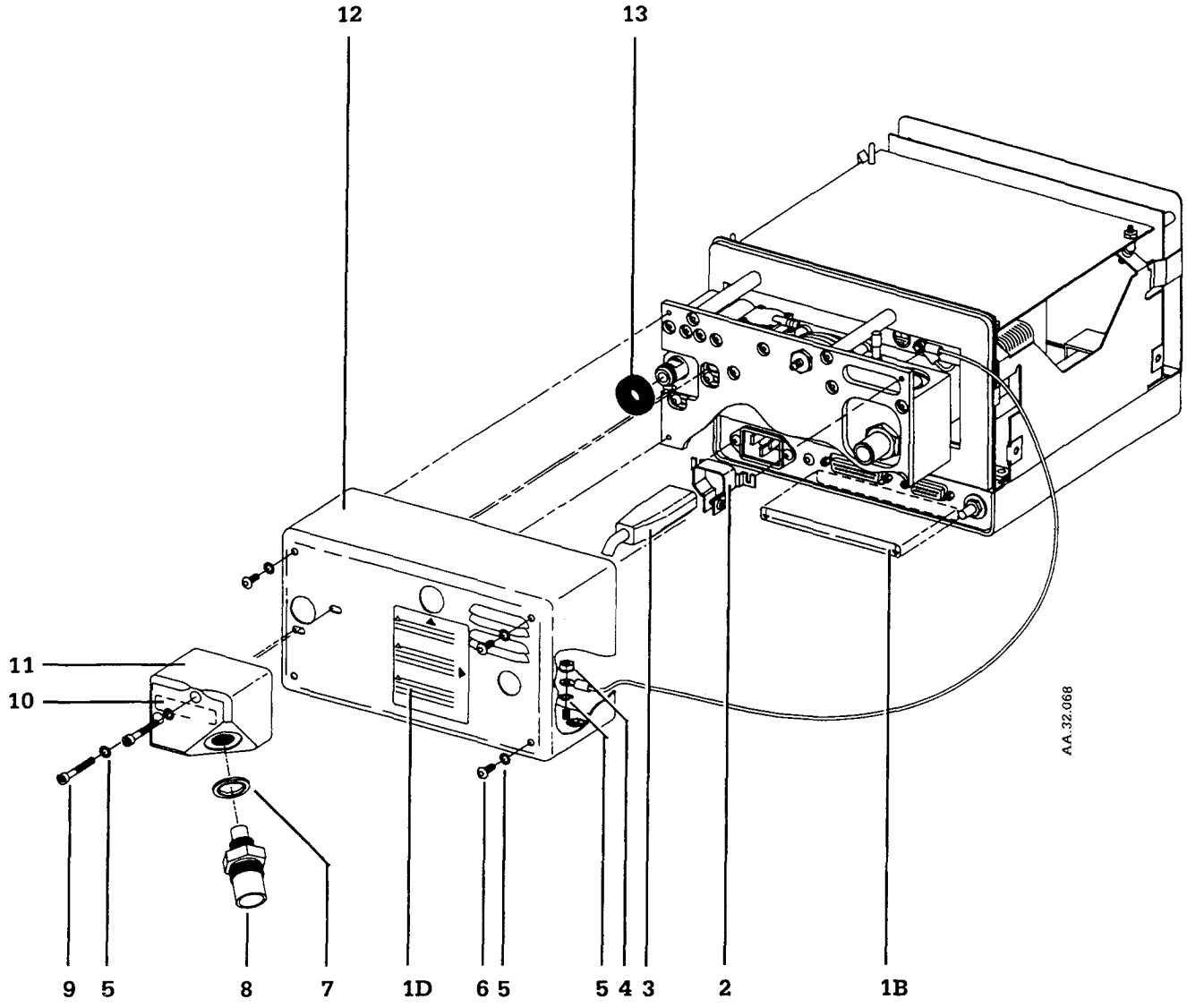


Figure 8-24 Pneumatic Cover, Excel Mount

Cover and Knobs

	Description	Stock Number	Quantity
1.	Washer, external lock, M4	9213-0540-003	
2.	Nut, Keps, 6-32 inch, with external lock washer	0202-1130-300	
3.	Cover Panel	0229-1001-710	
4.	Screw, M4 x 0.7, 12 mm long	0140-6226-112	(4)
5.	Knob, Push to Turn, (includes two, 4-40 inch setscrews and Torque Nut)	1500-3146-000	
6.	Knob, Knurled Conductive (includes two setscrews)	1500-3136-000	(3)
	Setscrew alone, M3 x 0.5 x 6 mm	0140-6217-104	
7.	Front Label (English)	1500-3162-000	
	Front Label (French)	1500-3242-000	
	Front Label (German)	1500-3221-000	
	Front Label (Italian)	1500-3256-000	
	Front Label (Swedish)	1500-3224-000	
	Front Label (Spanish)	1500-3249-000	
8.	Label, Set (English), Part G	1500-3281-000	
	Label, Set (French), Part G	1500-3247-000	
	Label, Set (German), Part G	1500-3229-000	
	Label, Set (Italian), Part G	1500-3261-000	
	Label, Set (Swedish), Part G	1500-3230-000	
	Label, Set (Spanish), Part G	1500-3254-000	

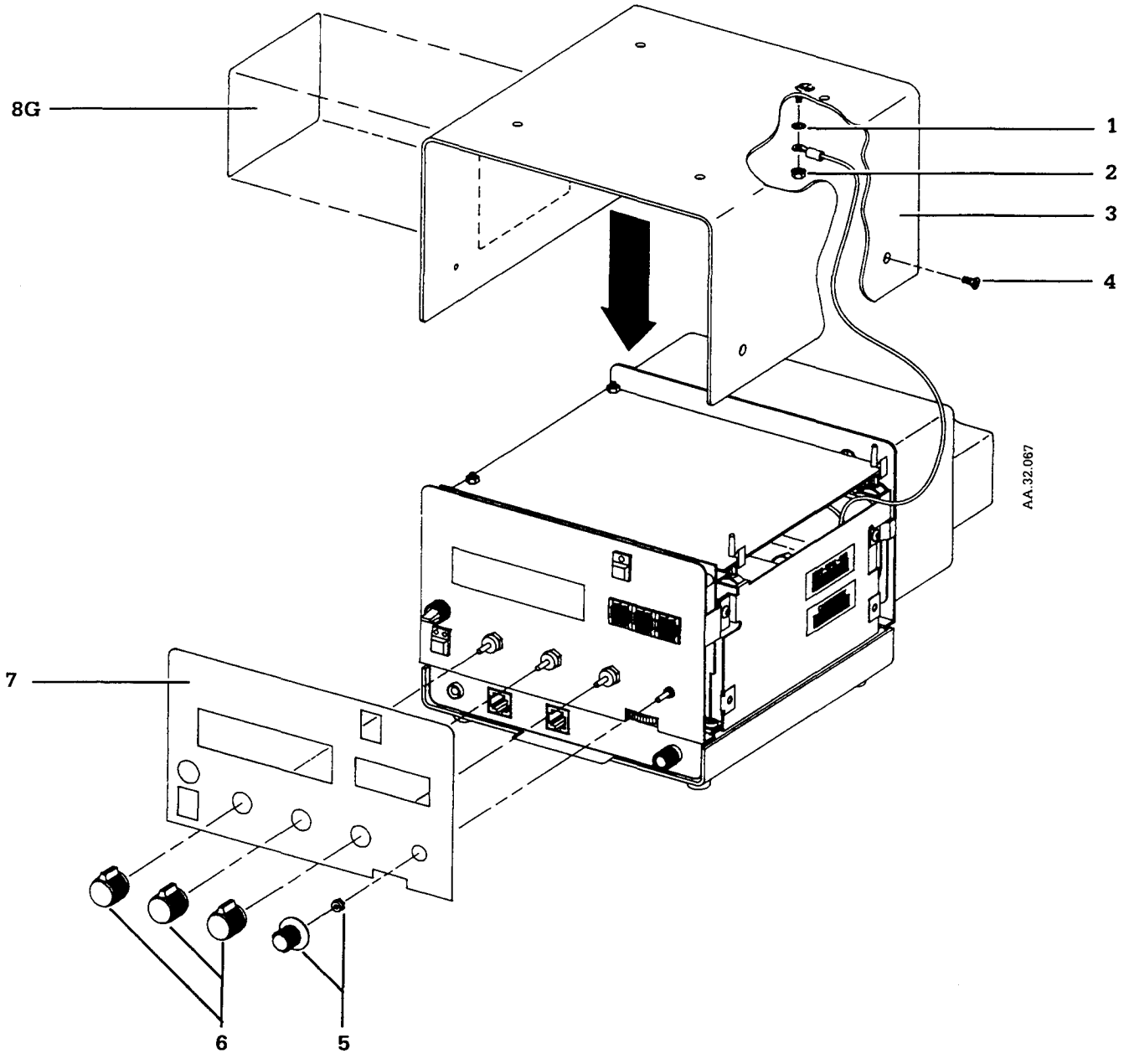


Figure 8-25 Cover and Knobs

Gas Supply Filter (Air Supply Only)

Gas Supply Filter Maintenance Kit — 1500-3320-000 —

Description

1. Gasket
3. Filter Element (5 micron)
5. 'O'-Ring

Gas Supply Filter and Bowl Replacement Kit — 1500-3319-000 —

Description

1. Gasket
2. Louver
3. Filter Element (5 micron)
4. Mounting Stud
5. 'O'-Ring
6. Clear Bowl with Drain Valve

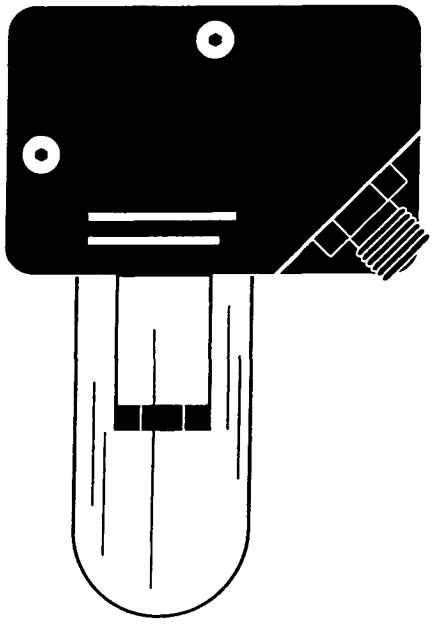


Figure 8-26 Gas Supply Filter Assembled

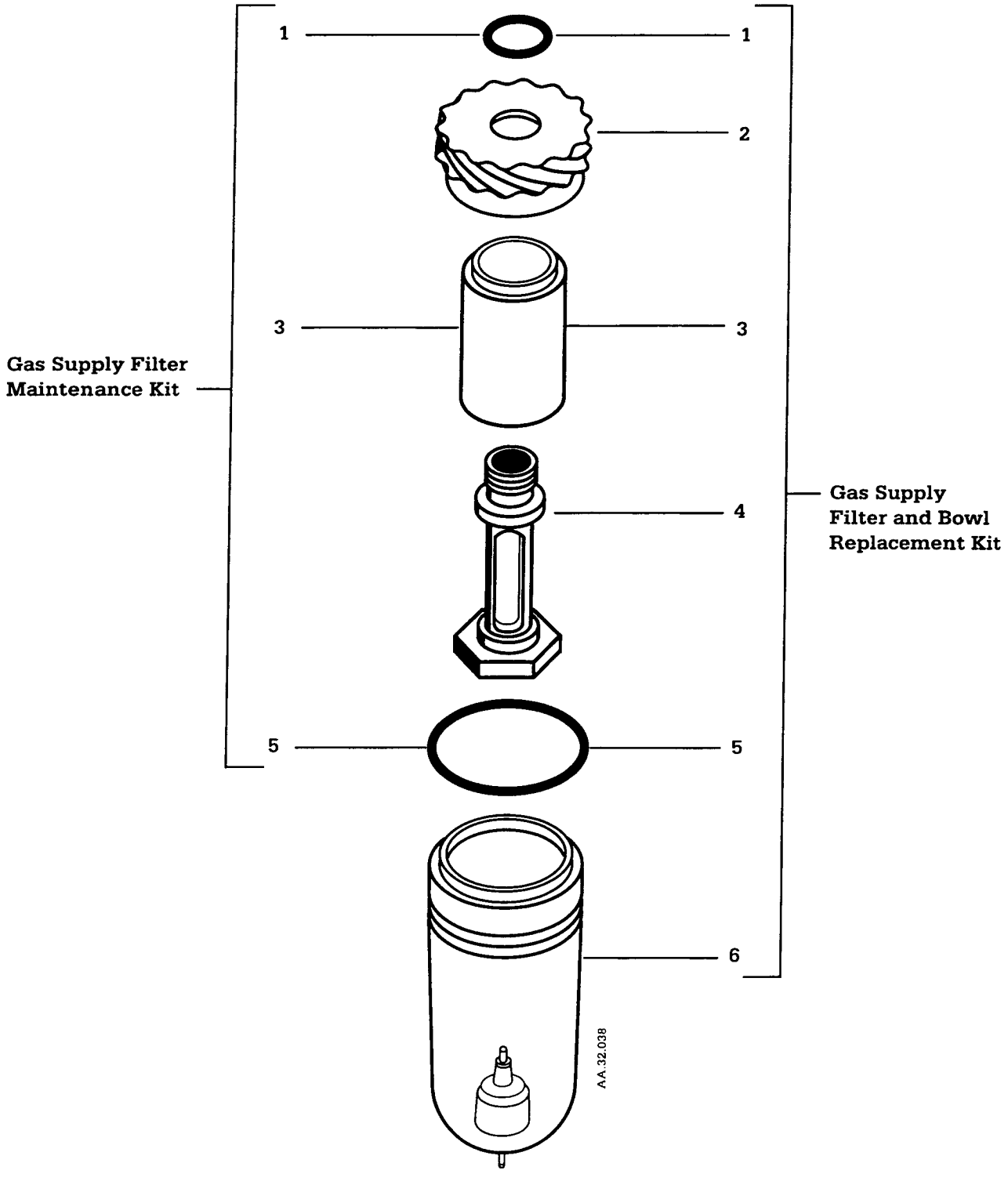


Figure 8-27 Gas Supply Filter Components

8.2 Mounting

Excel Right Side, Top Shelf

Description	Stock Number	Quantity
1. Screw, 10-32 x 3/8 inch, stainless steel	0140-6631-107	(8)
2. Washer, external lock, 10	0144-1110-231	(8)
3. Spacer	1001-5882-000	(4)
4. Entire Kit, Ventilator Mounting , Top Shelf	1001-8951-000	

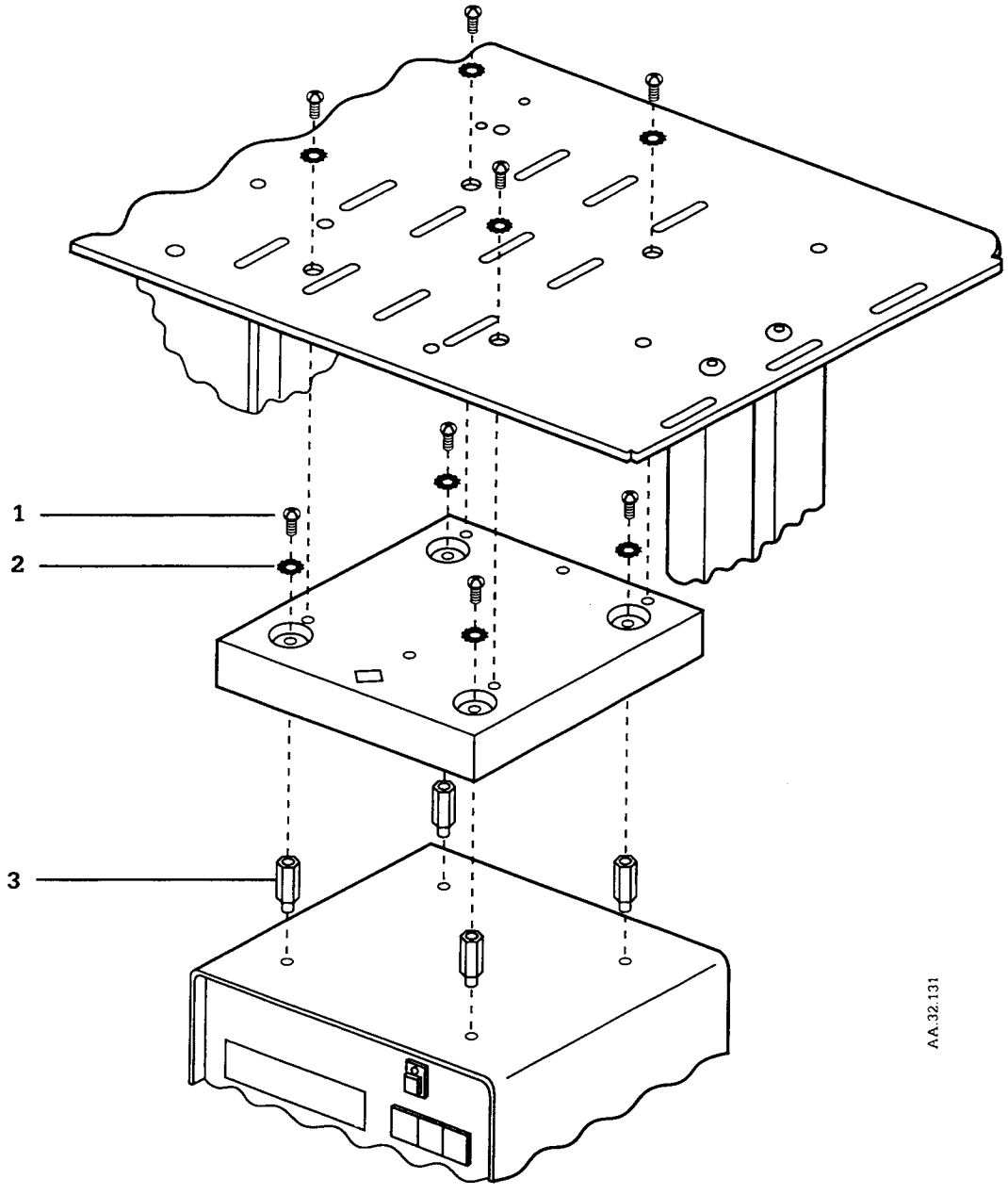


Figure 8-28 Excel Right Side, Top Shelf

Optional Arm

Description	Stock Number	Quantity
1. Washer, external lock, M4	9213-0540-003	(3)
2. Screw, M4 x 16, Pan Head Type 316, stainless steel,	9211-0440-163	(3)
3. Entire Kit, Ventilator/Bellows Mounting, Outboard	1001-8953-000	

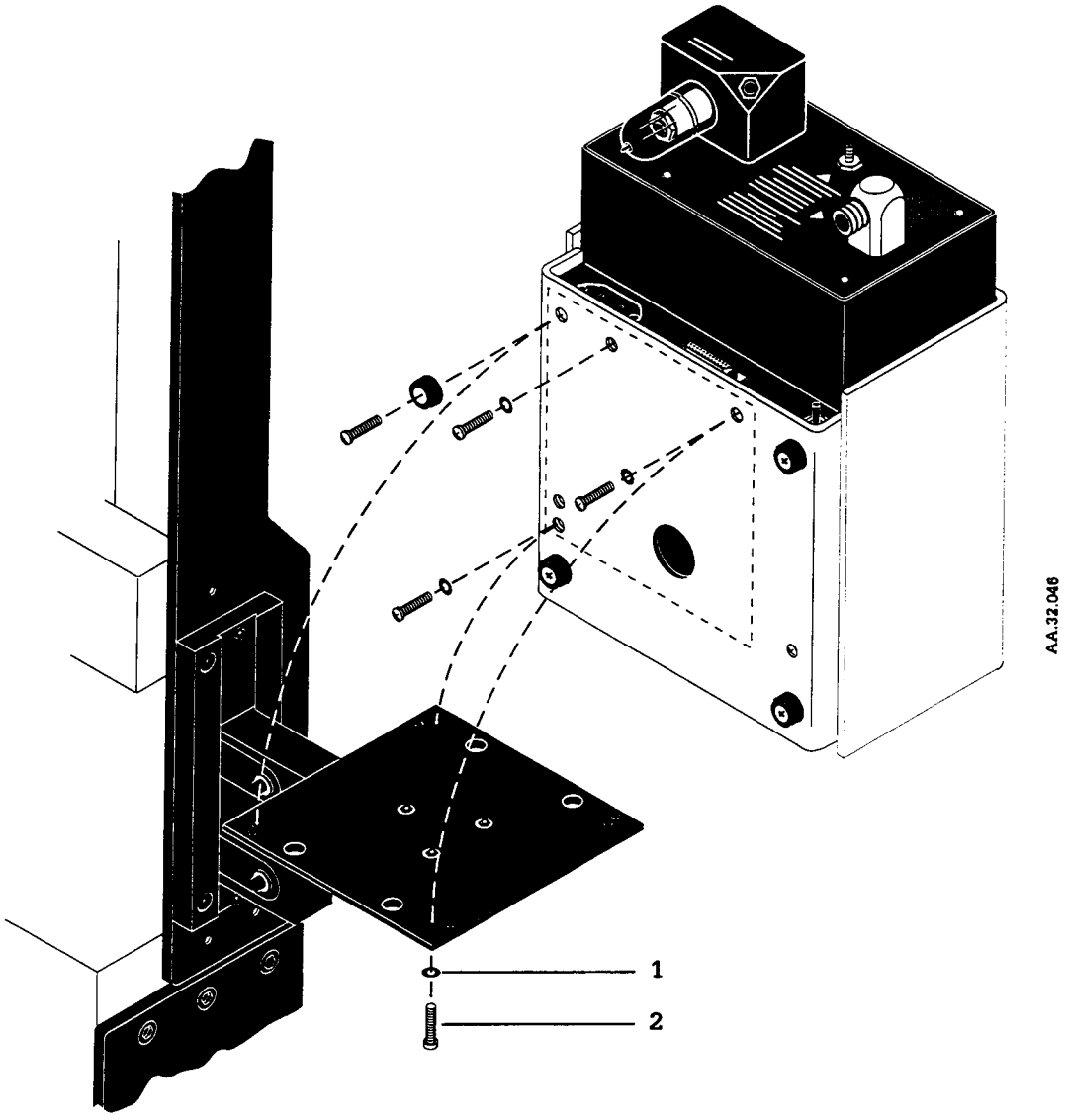


Figure 8-29 Optional Arm

8.3 Accessories

Sensor Related Parts	Stock Number
Volume Sensor clip assembly, ~2.4 m (8 foot) cable, English	1201-3000-000
Volume Sensor clip assembly, ~2.4 m (8 foot) cable, French	1500-3361-000
Volume Sensor clip assembly, ~4.9 m (16 foot) cable, English	1201-3002-000
Volume Sensor, extension cord kit, ~1.8 m (6 foot)	0237-2041-880
Volume Sensor cartridges (10 each), English	1201-3001-000
Volume Sensor cartridges (10 each), French	1500-3363-000
Pressure Sensing tube, 3 mm ID (1/8 inch) x ~2.4 m (8 foot)	0211-0721-500
Pressure sensing tee (patient-circuit adapter) 15 mm ID, 22 mm ID, 22 mm OD	0219-7547-700
Oxygen Sensor, with Housing Assembly ~1.8 m (6 foot), English	1200-3000-000
Oxygen Sensor, with Housing Assembly ~1.8 m (6 foot), French	1500-3362-000
Oxygen Sensor, extension cord kit ~1.8 m (6 foot)	0237-2040-880
Oxygen Sensor cartridge, English	1200-3001-000
Oxygen Sensor cartridge, French	1500-3364-000
Oxygen sensing tee patient circuit adapter (22 mm M, 22 mm F, 15 mm F)	1500-3115-000

Drive Gas tubes	Stock Number
Short, Corrugated Drive tube, 23 cm (9 inch)	0211-0118-300
Medium, Corrugated Drive tube, 100 cm (40 inch)	0211-0809-800
Long, Corrugated Drive tube, 195 cm (77 inch) with cuffs	0211-0842-300

8.4 Related Manuals

Manual	Stock Number
7800 (CAX) Ventilator, Operation and Maintenance Manual, English	1500-0134-000
Autoclavable Bellows Assembly, Supplement, English	1500-0250-000
7800 (CAX) Ventilator, Operation and Maintenance Manual, French	1500-0145-000
Autoclavable Bellows Assembly, Supplement, French	1500-0252-000
7800 (CAX) Ventilator, Operation and Maintenance Manual, Swedish	1500-0148-000
utoclavable Bellows Assembly, Supplement, Swedish	1500-0255-000
7800 (CAX) Ventilator, Operation and Maintenance Manual, Italian	1500-0147-000
Autoclavable Bellows Assembly, Supplement, Italian	1500-0254-000
7800 (CAX) Ventilator, Operation and Maintenance Manual, Spanish	1500-0149-000
Autoclavable Bellows Assembly, Supplement, Spanish	1500-0253-000
7800 (CAX) Ventilator, Operation and Maintenance Manual, German	1500-0146-000
Autoclavable Bellows Assembly, Supplement, German	1500-0251-000

9/Schematics

Schematics are subject to change without notice.

Circuit boards are available only as complete assemblies.

Description	Page
Pneumatic Schematic	9-2
Filter, Breaker, Selector, Transformer	9-3
Power Supply board	9-4
Control Board	9-5
Front Panel board	9-10
Pressure Transducer board	9-12
Header Board	9-15
EMC/Interface board	9-16
Excel/Ventilator Interface Cable (Excel Mount only)	9-17
Patient Interface Box and Internal Excel Machine (Excel Mount only)	9-18

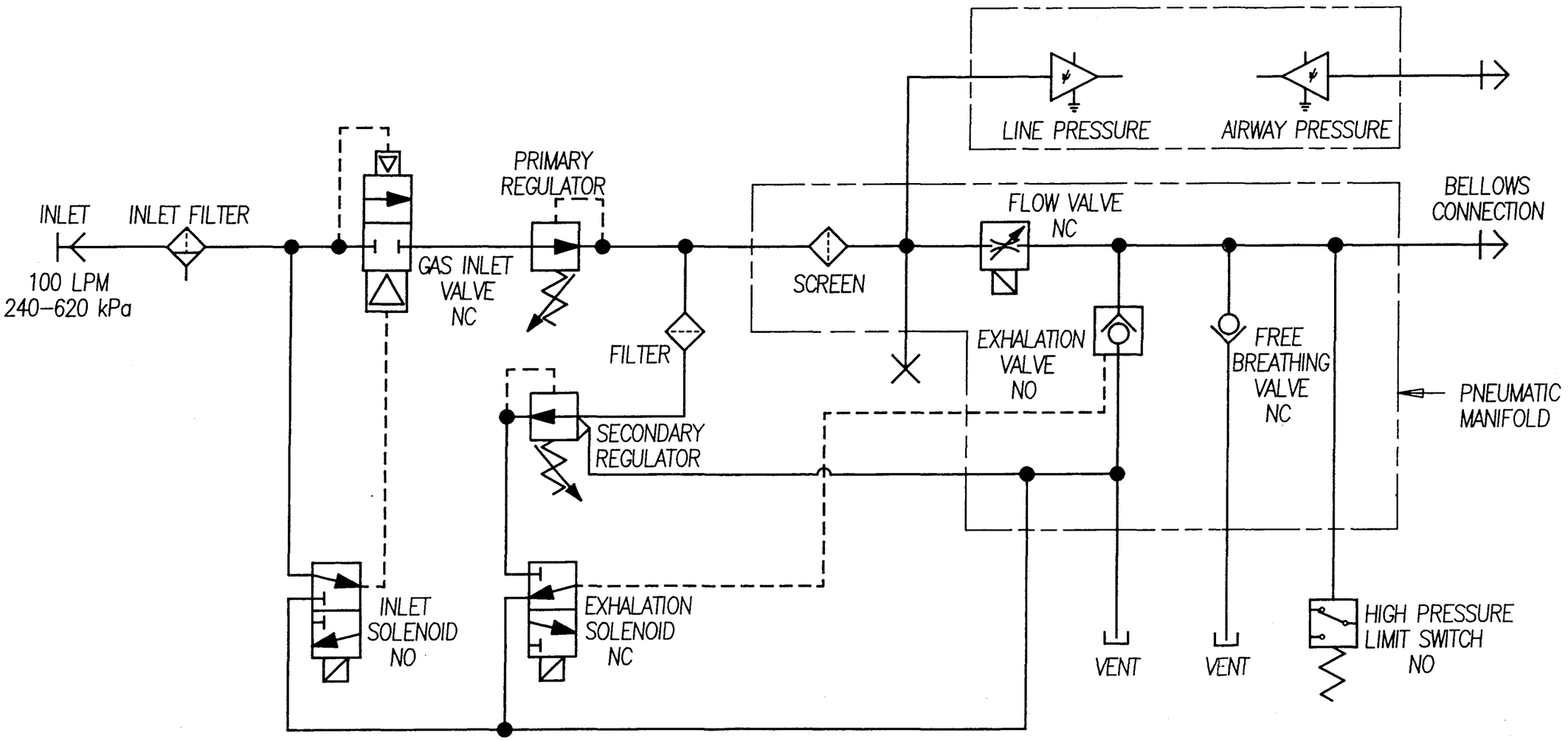


Figure 9-1 Pneumatic Schematic

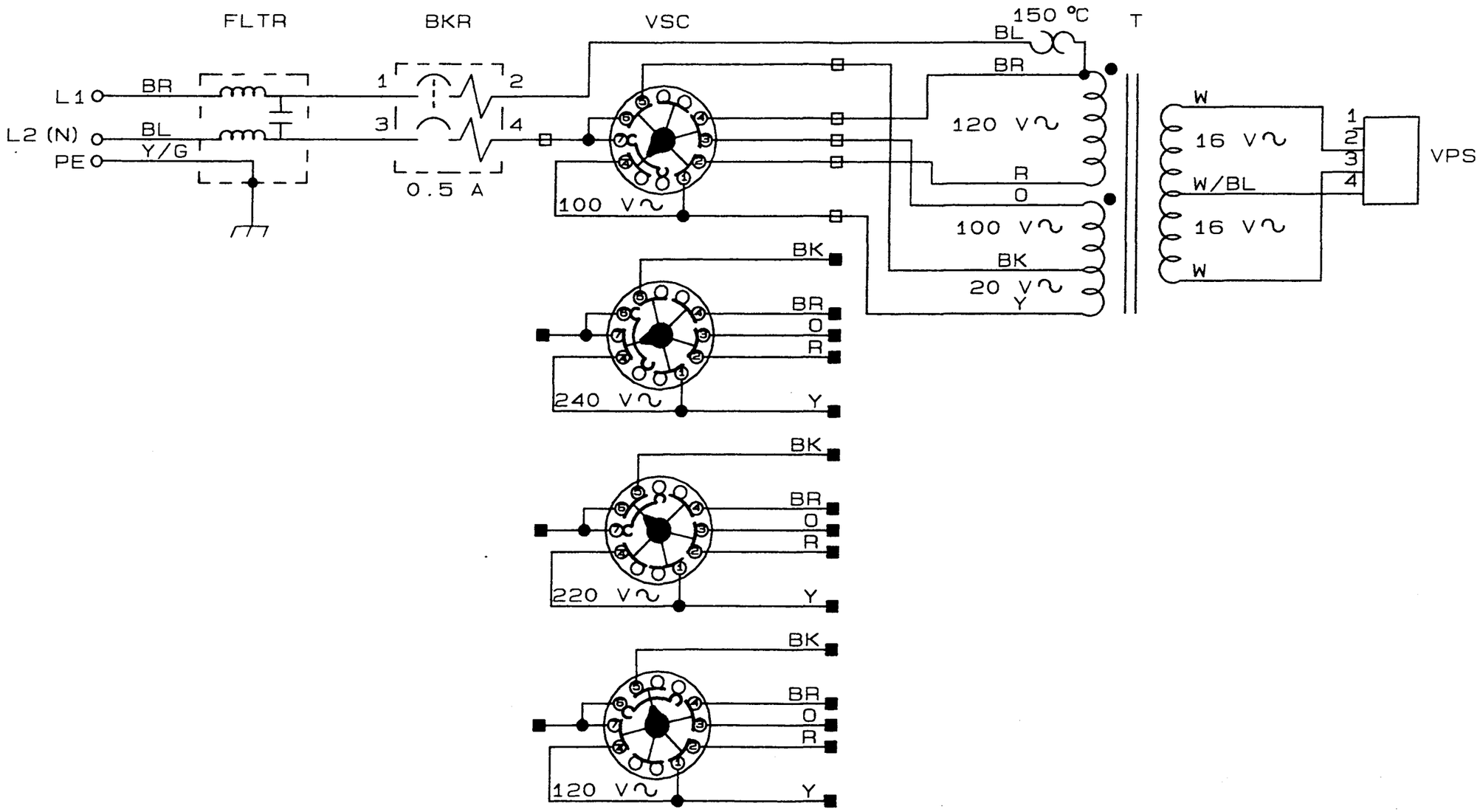


Figure 9-2 Filter, Breaker, Selector, Transformer

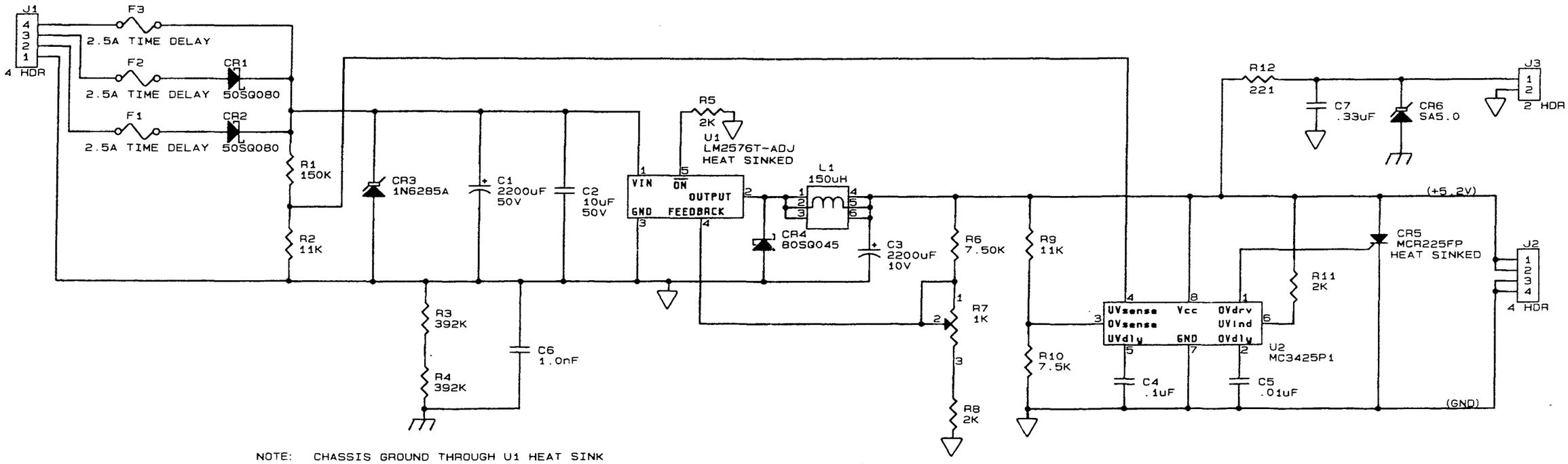


Figure 9-3 Power Supply Board

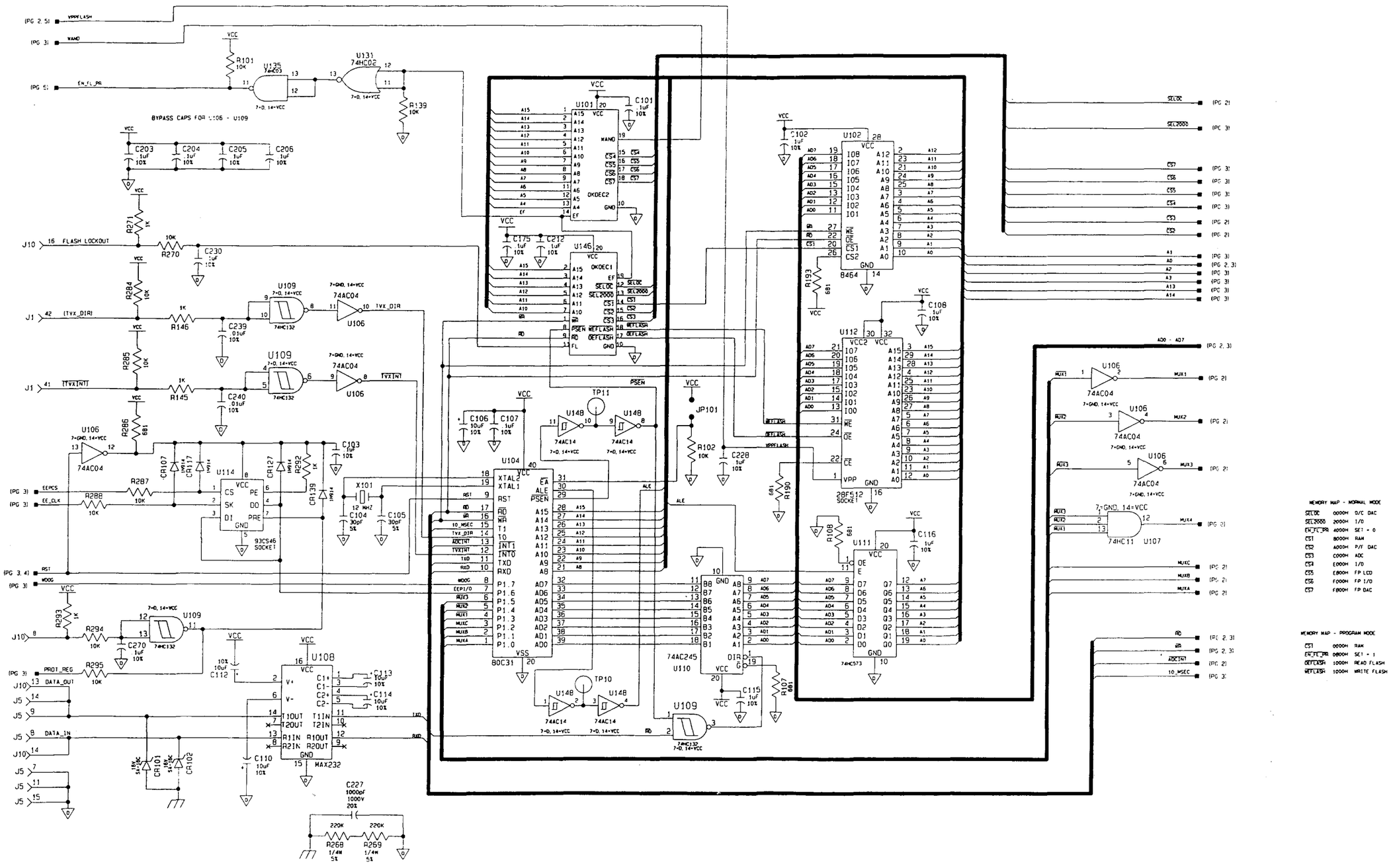


Figure 9-4 Control Board, sheet 1 of 5

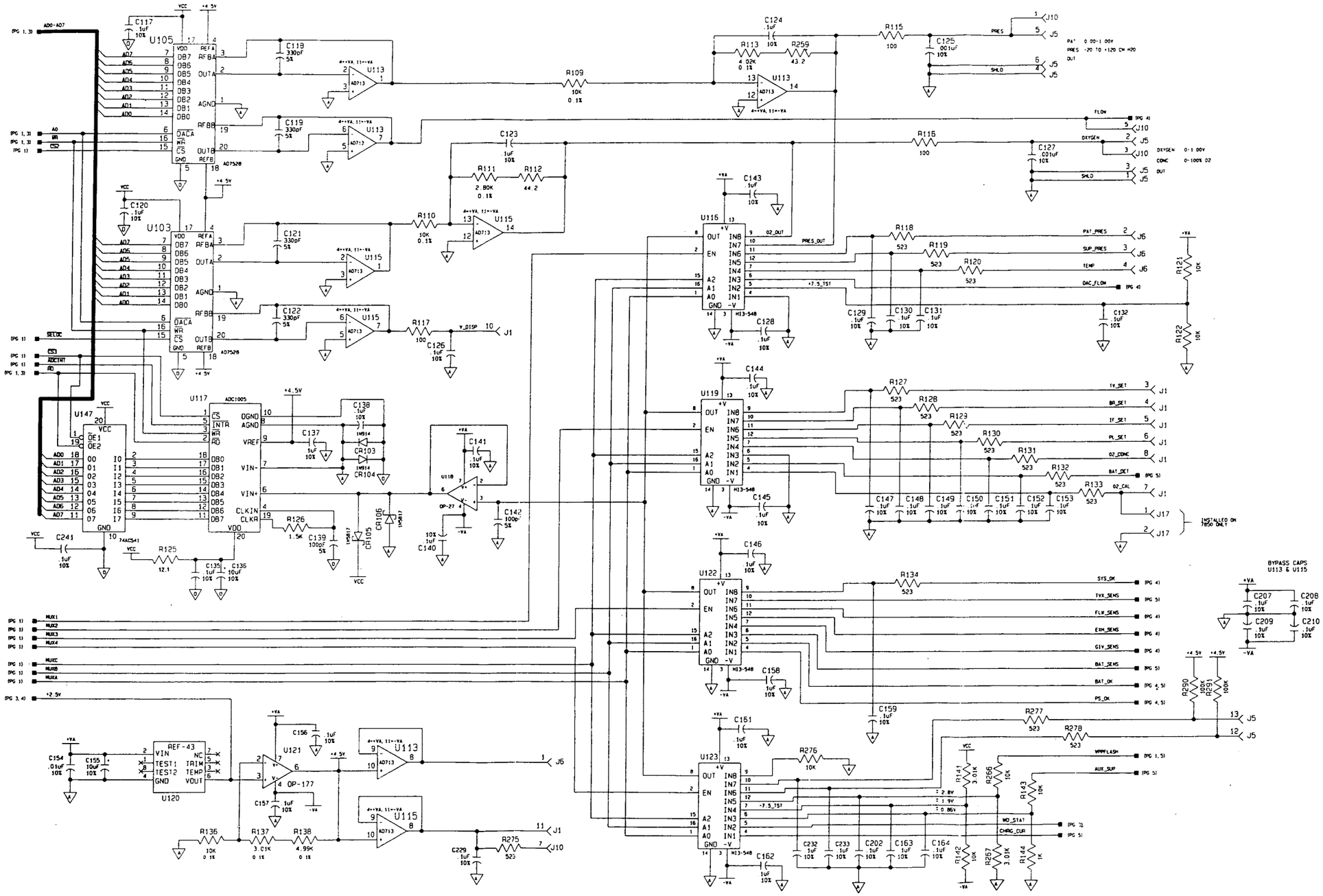


Figure 9-5 Control Board, 2 of 5

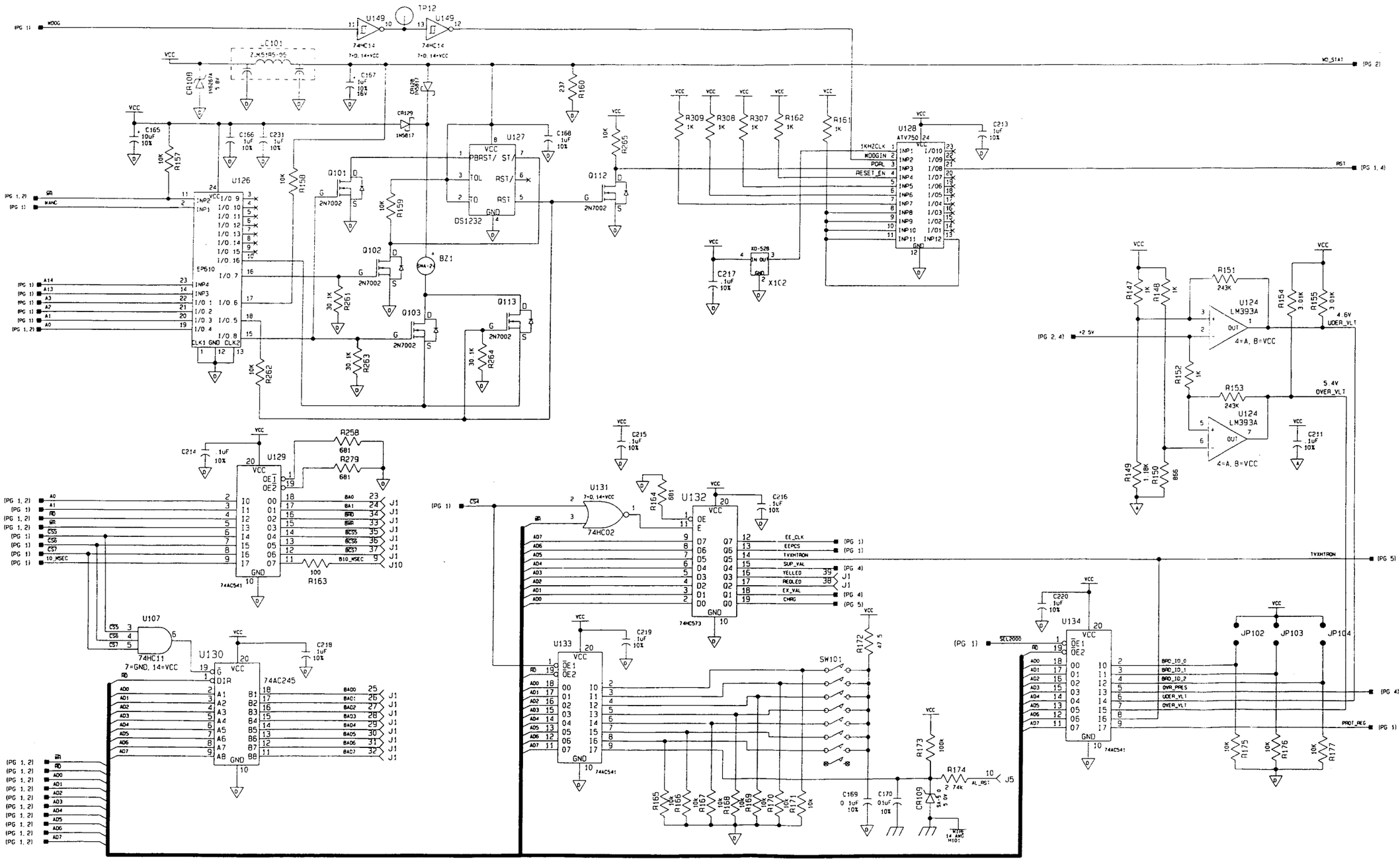


Figure 9-6 Control Board, 3 of 5

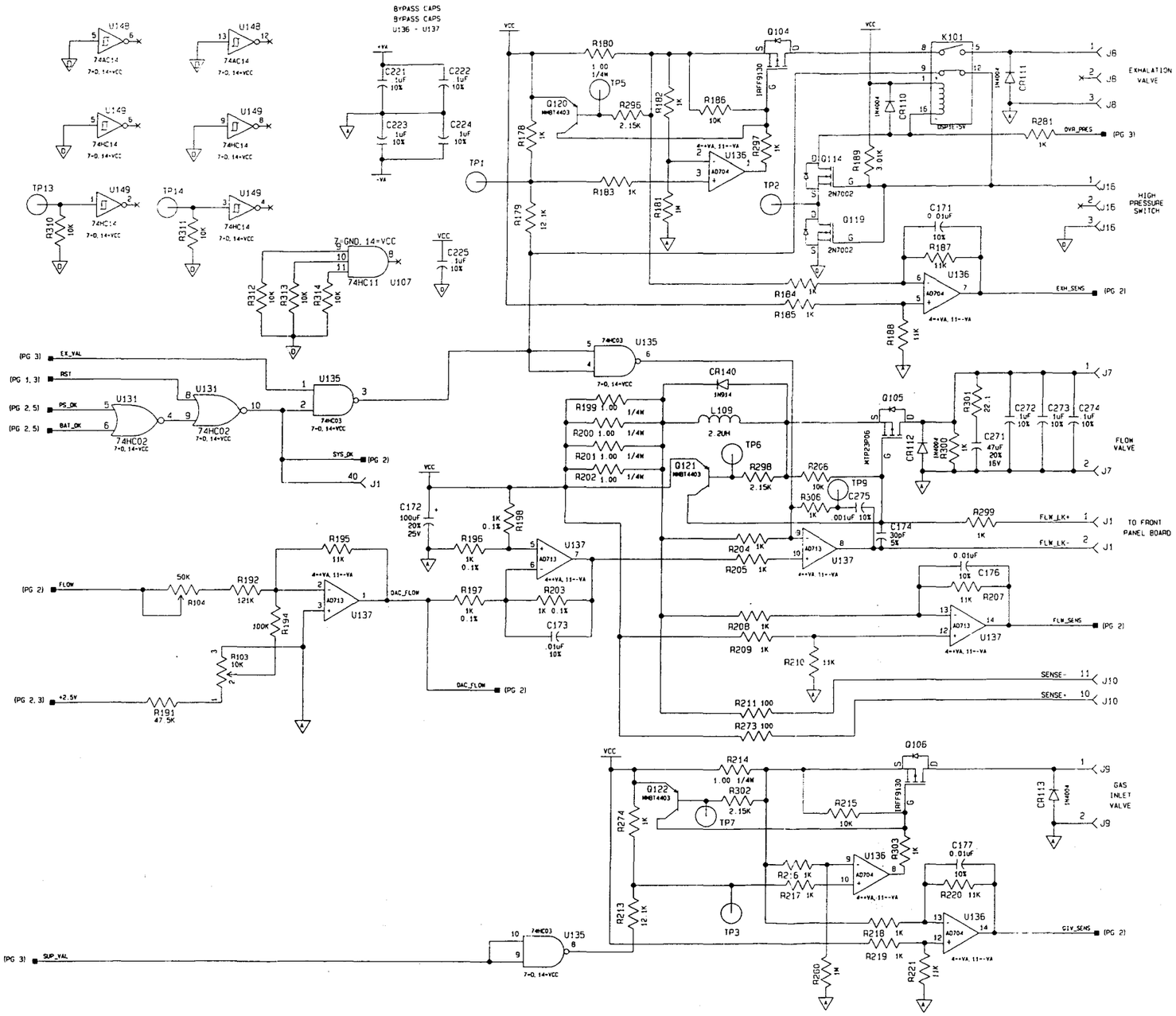


Figure 9-7 Control Board, 4 of 5

Figure 9-8 Control Board, 5 of 5

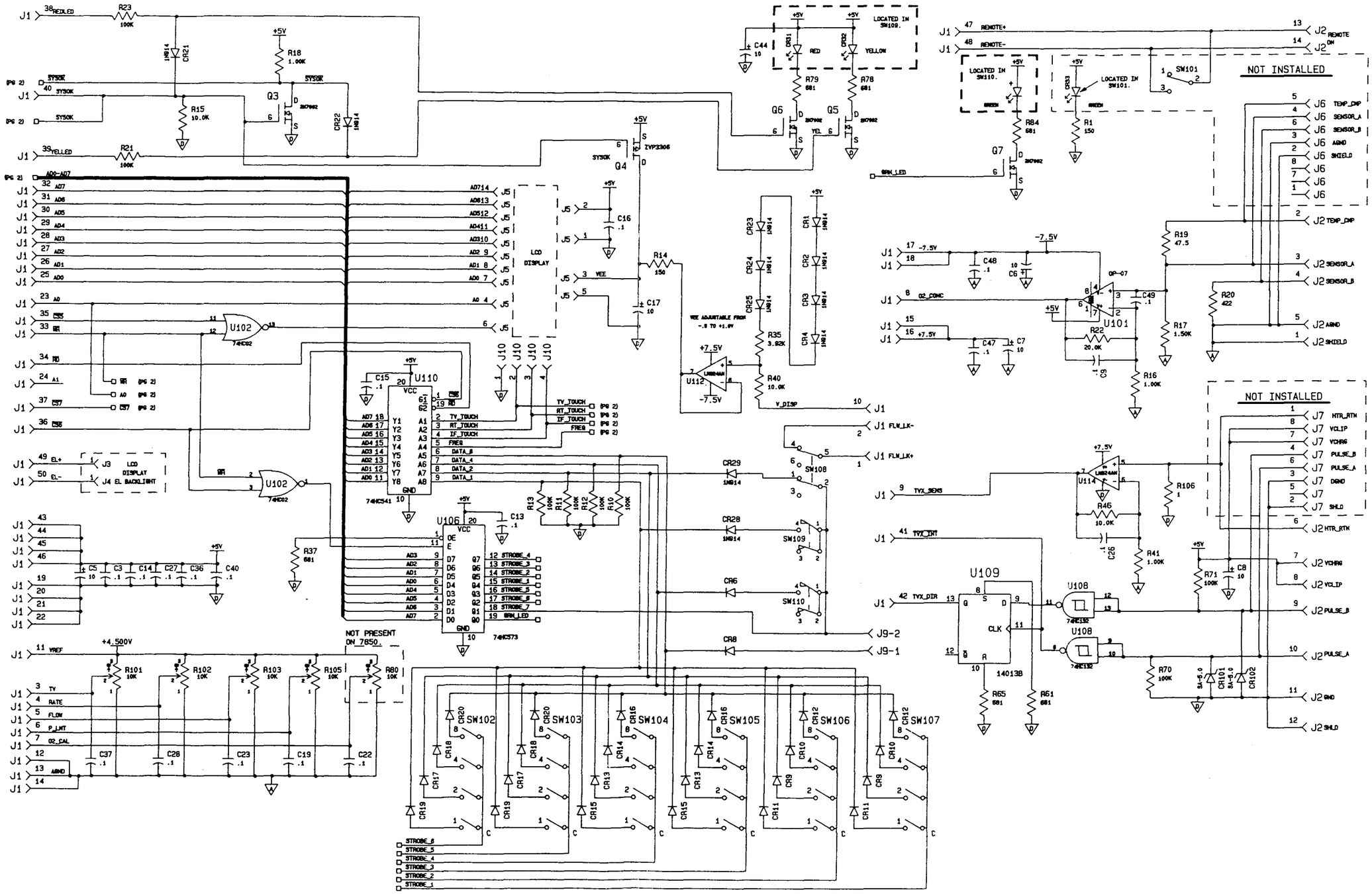


Figure 9-9 Front Panel Board, sheet 1 of 2

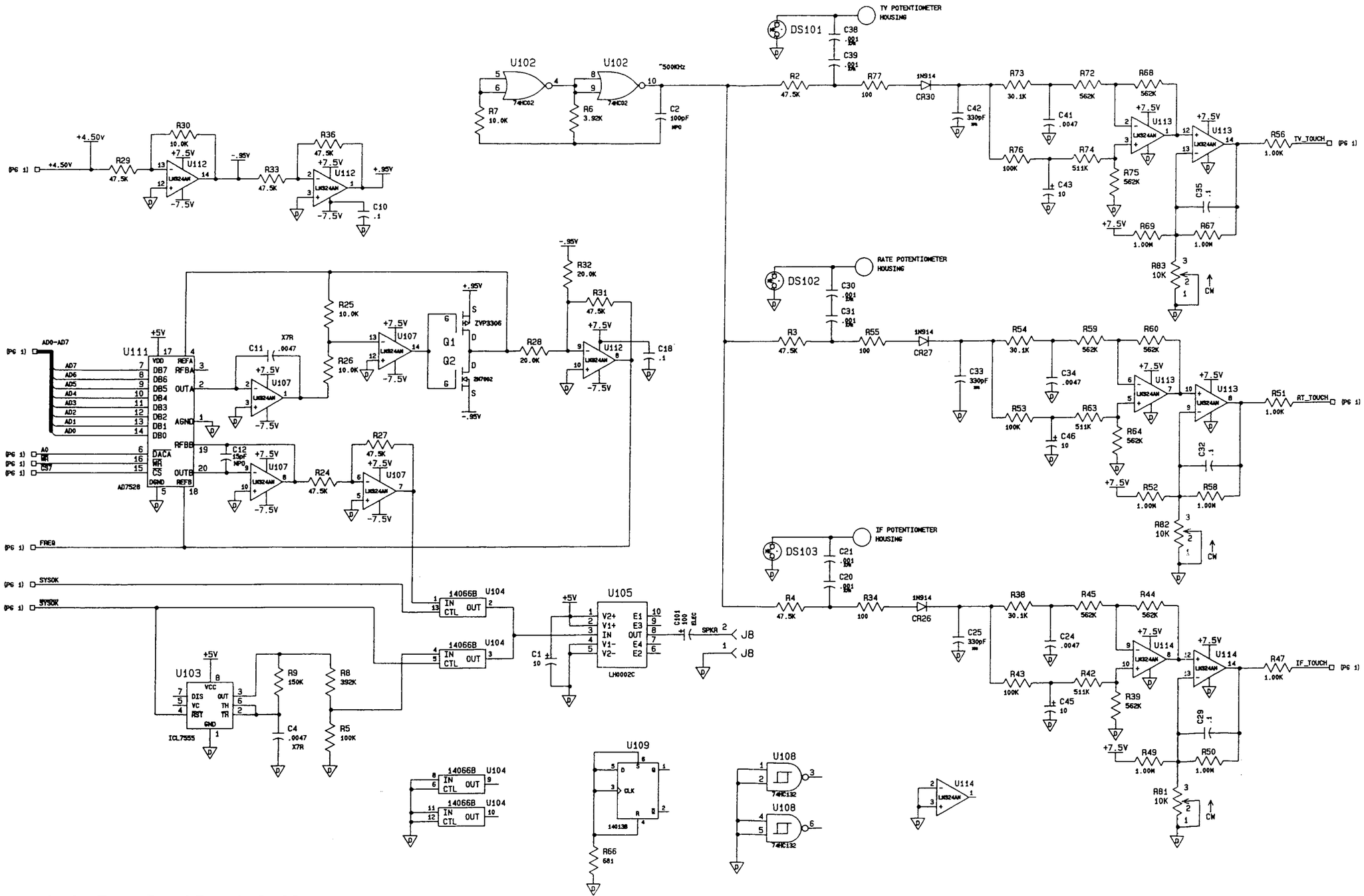


Figure 9-10 Front Panel Board, 2 of 2

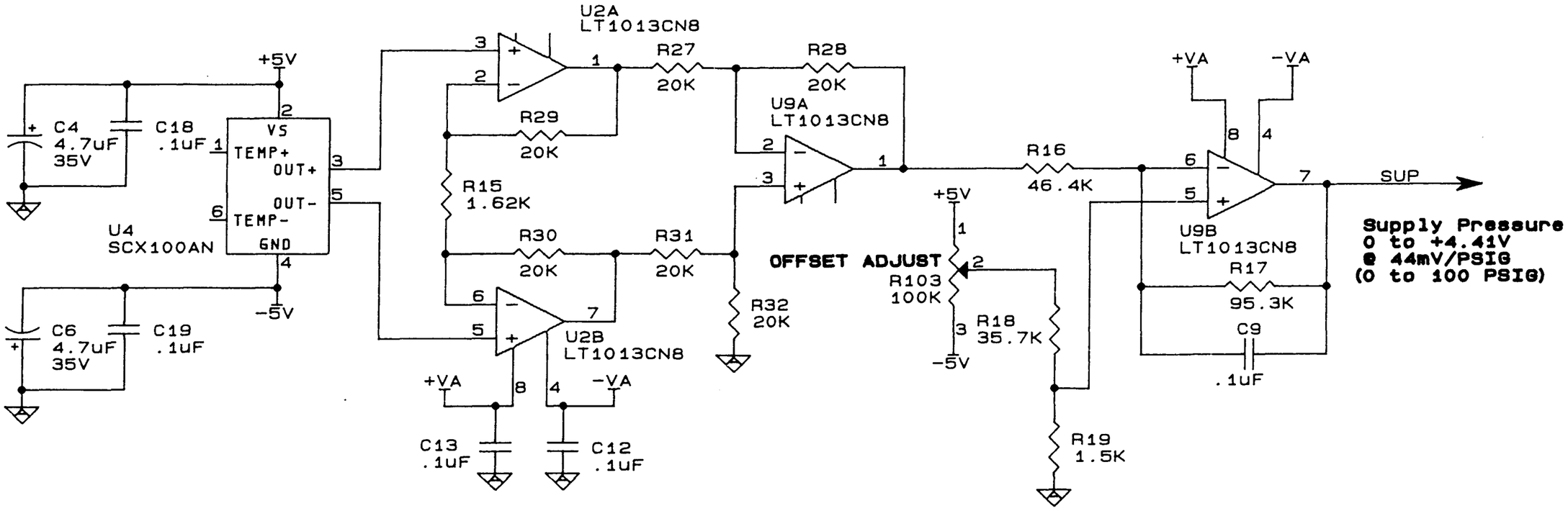


Figure 9-11 Pressure Transducer Board, sheet 1 of 3

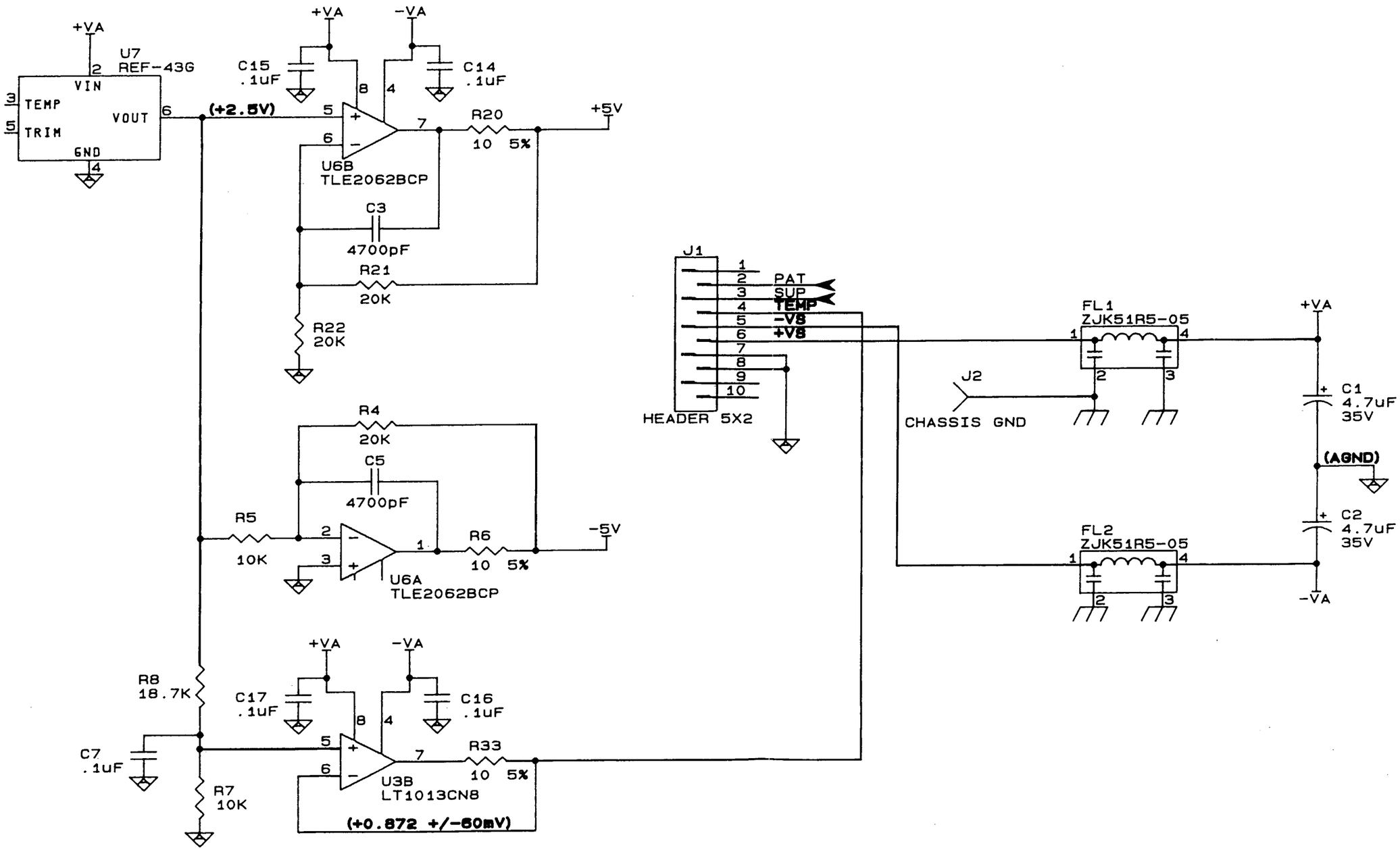


Figure 9-12 Pressure Transducer Board, 2 of 3

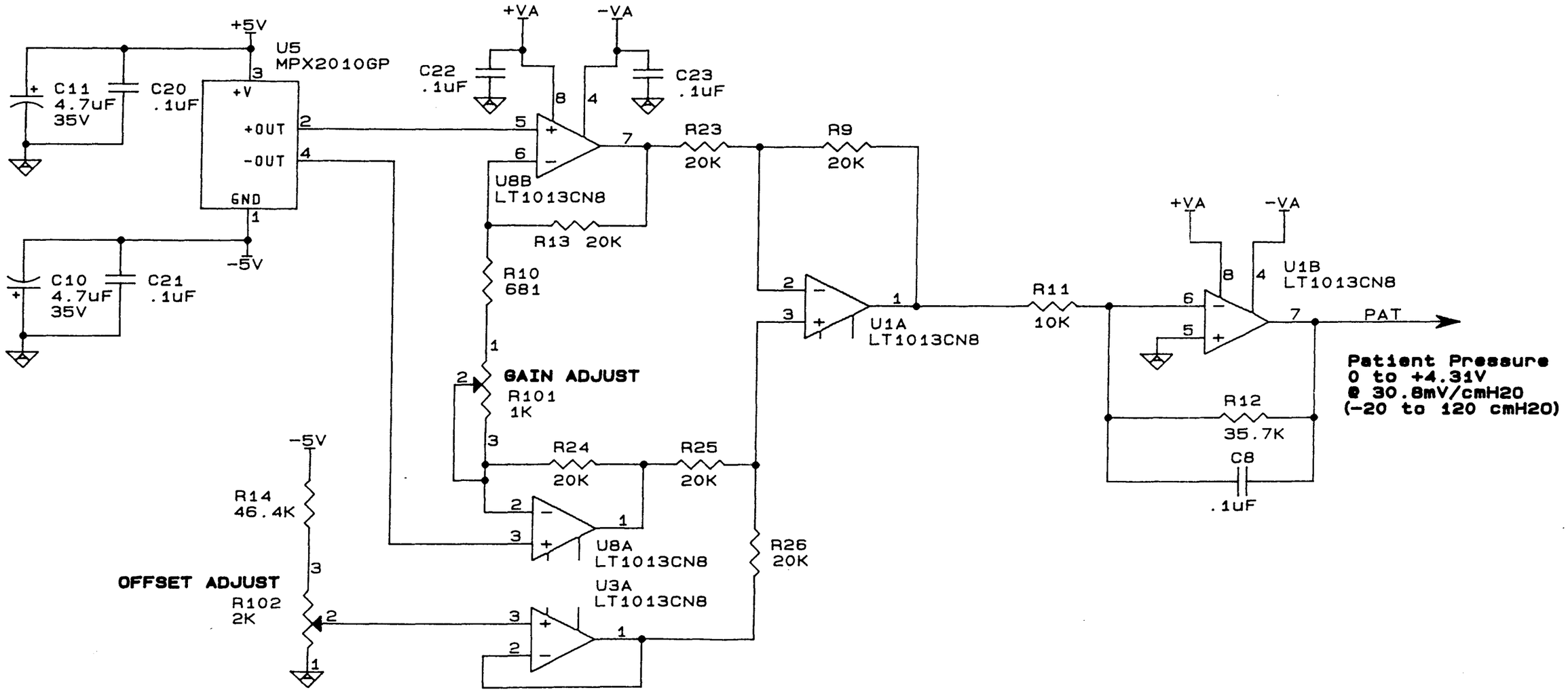


Figure 9-13 Pressure Transducer Board, 3 of 3

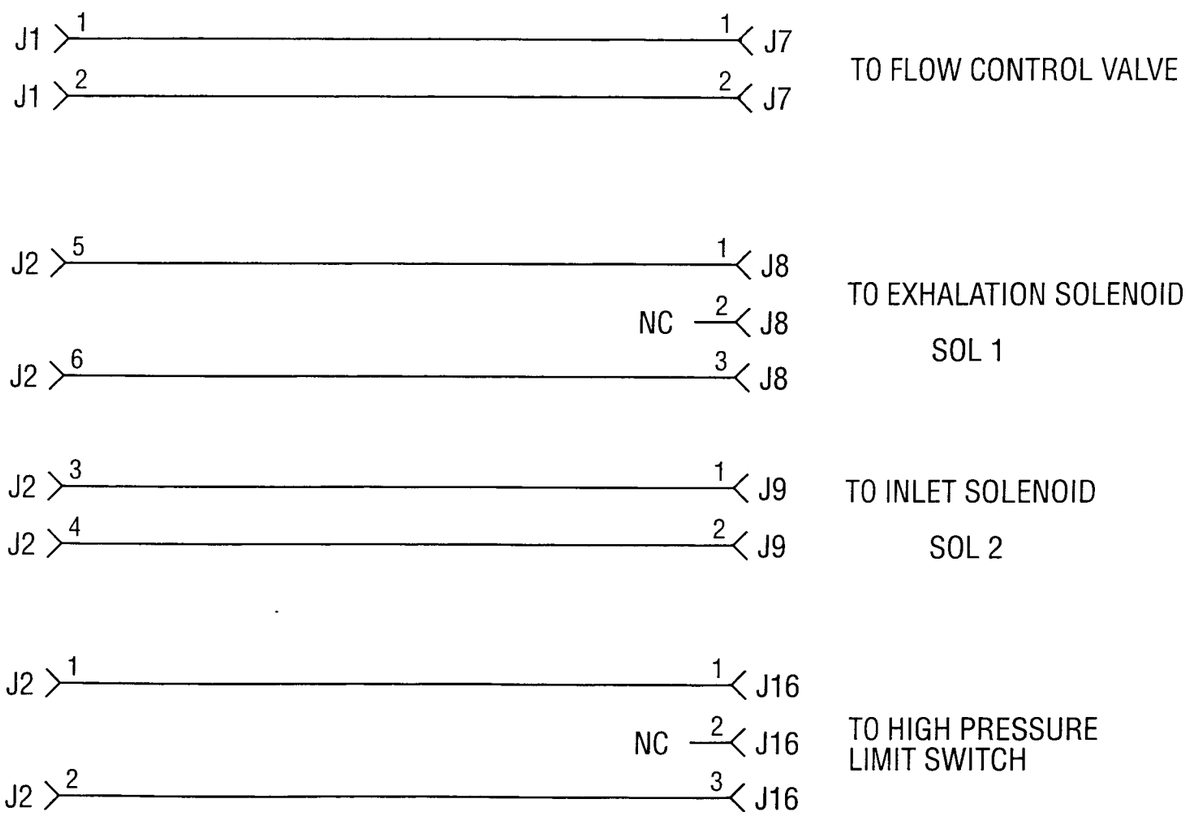


Figure 9-14 Header Board

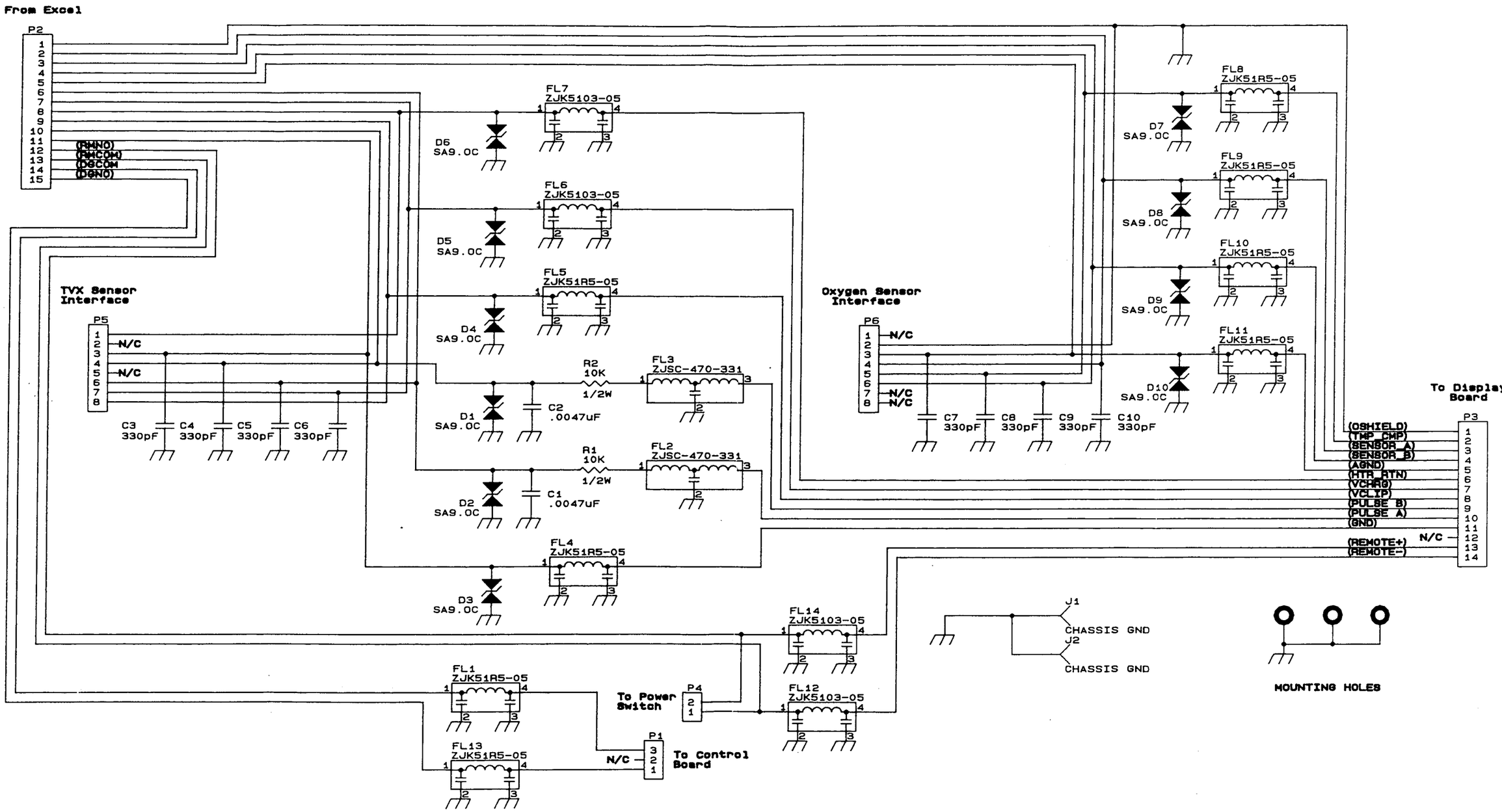


Figure 9-15 EMC/Interface Board

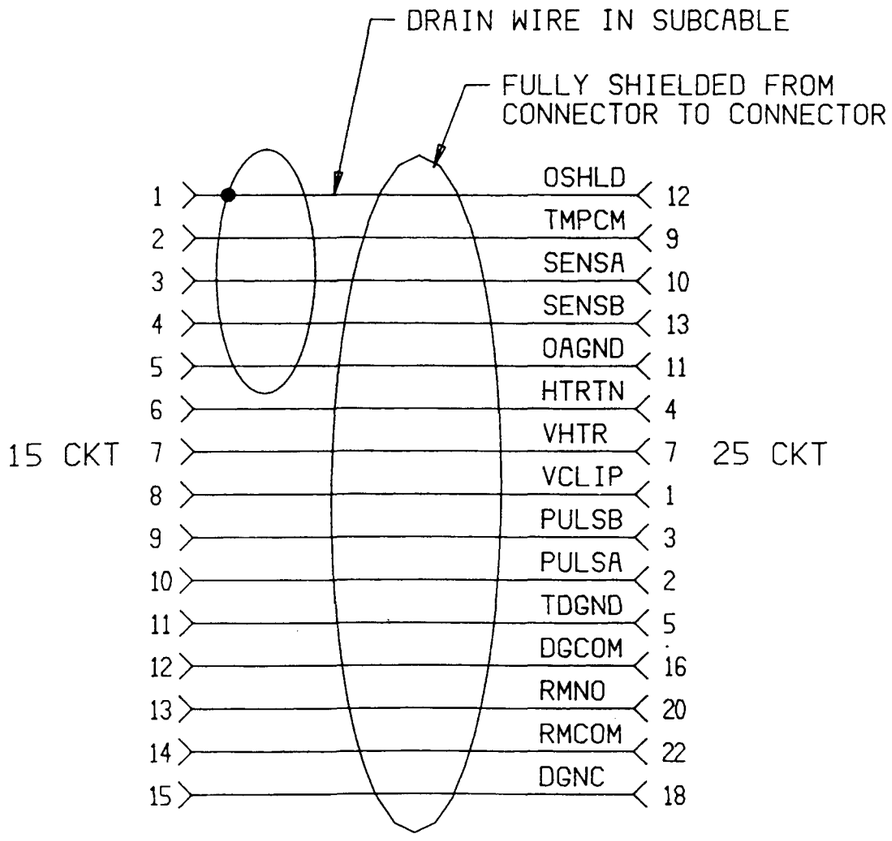


Figure 9-16 Excel/Ventilator Interface Cable (Excel Mount only)

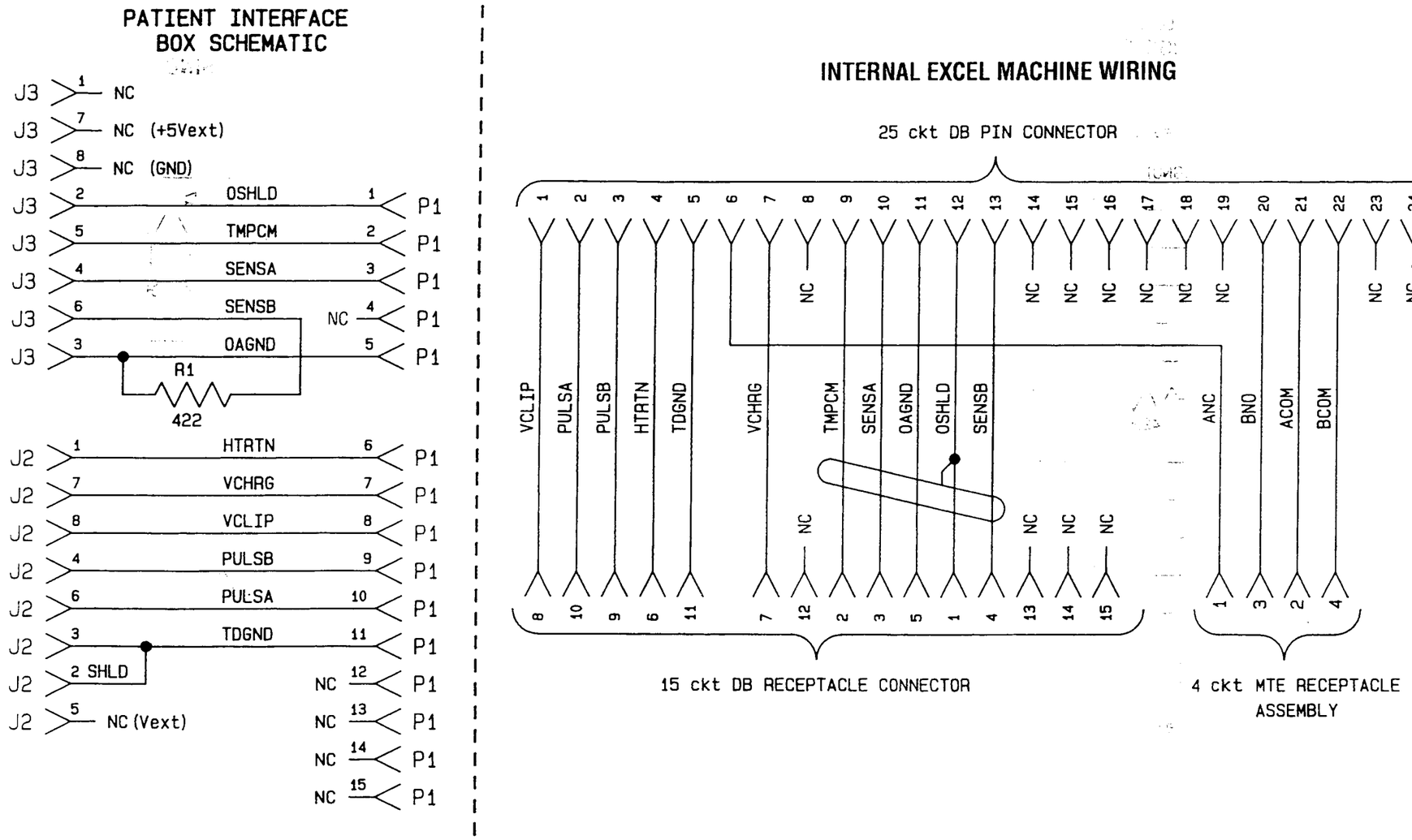


Figure 9-17 Patient Interface Box and Internal Excel Machine (Excel Mount Only)

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